LAUDA

Operating Instructions

LAUDA Ultra-Kryomats®
RUL 80 (-D), RUL 90 (-D)
RUK 50 (-D), RUK 50 W (-D),
RUK 90 (-D),RUK 90 W (-D)
RUK 50-P, RUK 50 W-P, RUK 90-P, RUK 90 W-P
RUK 40 S, RUK 40 SW, RUK 90 S, RUK 90 SW

from series A 01
software version 2.14
01/02
YAUE0005

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1 Brief Operating Instructions

Even if you find these brief instructions initially sufficient please also read the following sections, especially Section 4: "Safety devices and warning notes".
For safe operation of the equipment it is essential that the information given in these Operating Instructions is observed.

Check the Ultra-Kryomat® and the accessories during unpacking for any transport damage and if necessary inform the carrier or the postal authority.

Assemble the unit according to Section 6 and add extra items as appropriate. Water-cooled units (marked "W" in the type designation) have to be connected to the mains water supply with the hoses supplied. See Section 6. On air-cooled units the spacing of the grilles from any object which might obstruct the free air flow must be at least 0.5 m.

1.1 Fitting the tubing to the pump connections:

Without external system: link the pump connectors together to ensure better circulation inside the bath, using e.g. EPDM tubing (up to 120°C) or better the metal tubing.

With external system: connect the tubings to the external system.
Protect the tubing with hose clips against slipping off.

Use only softened water or LAUDA bath liquids (Section 5). Fill up the bath to a level about 1 cm below the plastic cover plate.

Check the supply voltage against the details on the label. Insert the mains plug. On water-cooled units turn on the water tap.

Switch on the supply switch (green lamp lights up).

On 3-phase units the mains switch (red/yellow) has to be switched on first. If the unit (except RUL 80 (-D), RUL 90 (-D) and RUK xx-W (-D)) has not previously been operating on this supply, check the direction of the rotation of the pump motor; in the case of air-cooled units (without W in the type designation) also check the condenser fans (see Item 8.3.1).

The display shows the software version and the type of the unit, followed by the standard display.

Select the required indications using the keys 

and 

in the SHIFT mode. It is useful to show the setpoint (TS) in display line 2 (L2) (see Item 8.3.2).

Set the overtemperature switch-off point (TO) slightly above the operating temperature.

If there is an error message, press the key 

and perhaps increase TO.

1.2 Important:

TO must be at least 25K below the fire point of the bath liquid used (see Item 8.3.4)!

When connecting up an external system please check that filling this system does not cause the level inside the thermostat to fall more than permitted.

When the thermostating liquid has reached the setpoint the symbol  or  starts to flash in line 1 (L1) of the display.
After the unit has stabilised the bath temperature (Ti) corresponds to the setpoint (TS). If the refrigerating system has been out of use for some time it may take up to 20 minutes (depending on the ambient temperature and the type of unit) until the rated cooling capacity is available.

1.3 Operating safety

The thermostat must be operated with non-flammable bath liquids or with flammable bath liquids up to 25°C below their fire point, otherwise there is the possibility that a flammable atmosphere may form (see Item 4.2).

1.4 Warning

The outflow and return pipes of the pumps reach the operating temperature, i. e. even temperatures above 70°C. Touching them is dangerous because of very high or low temperatures!

2 Technical data (to DIN 58966)

Type			**RUL 80 RUL 80-D**	**RUL 90 RUL 90-D**	**RUK 50 RUK 50-D**	**RUK 50 W RUK 50 W-D**	**RUK 90 RUK 90-D**	**RUK 90 W RUK 90 W-D**
Working temperature range		(°C)	-80...100	-90...100	-50...100	-50...100	-90...100	-90...100
Ambient temperature range		(°C)	5...35	5...35	5...35	5...35	5...35	5...35
Condenser cooling			Air	Air	Air	Water	Air	Water
Temperature setting/ resolution		(°C)	membrane keypad with 16 keys, setpoint input with 0.01°C resolution					
Bath temperature measurement			built-in digital thermometer with 0.01°C resolution; accuracy and stability of measurement (electronics without probe) better than 0.05 % ± 0.05 K *). Temperature probe Pt 100 to DIN IEC 751, Class B, can be calibrated additively at each measurement point.					
Display			back-lit LCD matrix display, 2 lines with 16 signs each, 10 mm character height					
External temperature measurement			2 separate temperature measurement circuits for external Pt 100 to DIN IEC 751 in 4-wire circuit, accuracy and stability of measurement better than 0.05% ± 0.05 K *), can be calibrated additively at each measurement point. One probe produces the measurement for external control.					
Temperature control			modified PID/PI controller with automatic structure selection. Control parameters through auto-adaptation or manual input. With external control a cascade controller operates on the measurement of one of the two external circuits (T1 or T2)					
Temperature variation (at –10°C)		(±°C)	0.02...0.05*)	0.02...0.05*)	0.02...0.05*)	0.02...0.05*)	0.02...0.05*)	0.02...0.05*)
Heating rating, max.		(kW)	1.2	1.2	2.0	2.0	2.0	2.0
Cooling capacity (eff.): (with Ethanol at 20°C ambient temperature)	20°C	(KW)	1.0	1.2	2.5	3.0	1.7	2.0
	0°C		0.8	1.15	2.2	2.5	1.4	1.6
	–10°C		0.7	1.1	2.0	2.2	1.3	1.5
	–20°C		0.6	1.0	1.4	1.4	1.2	1.4
	–40°C		0.5	----	0.4	0.4	1.1	1.2
	–50°C		0.45	0.8	0.15	0.15	1.0	1.1
	–60°C		0.4	0.6	----	----	0.8	0.9
	–80°C		0.1	0.25	----	----	0.25	0.25
	–85°C		----	0.13	----	----	----	----
	–90°C		----	----	----	----	0.06	0.06
Safety system			Overtemperature protection with selectable switch-off point, low-levelprotection to EN 61010 FL (DIN 12879 Class 2). Additionally 10-stage level indication on the display.					
Simplex pump								
Pump output against zero head		(l/min)	22	22	22	22	22	22
max. pump pressure		(bar)	0.5	0.5	0.5	0.5	0.5	0.5
Duplex-pump (-D)								
Pump output; pressure/suction		(l/min)	20 ; 15	20 ; 15	20 ; 15	20 ; 15	20 ; 15	20 ; 15
max. pump pressure (pressure/suction)		(bar)	0.5 ; 0.33	0.5 ; 0.33	0.5 ; 0.33	0.5 ; 0.33	0.5 ; 0.33	0.5 ; 0.33

Type		**RUL 80** **RUL 80-D**	**RUL 90** **RUL 90-D**	**RUK 50** **RUK 50-D**	**RUK 50 W** **RUK 50 W-D**	**RUK 90** **RUK 90-D**	**RUK 90 W** **RUK 90 W-D**
Pump connections		M 16x1; Nipples 13 Ø	M 16x1; Nipples 13 Ø	M 16x1; Nipples 13 Ø	M 16x1; Nipples 13 Ø	M 16x1; Nipples 13 Ø	M 16x1; Nipples 13 Ø
Filling volume, max.	(L)	9...14	13...18	19...27	19...27	19...27	19...27
Bath opening (W x D)	(mm)	250x175	250x175	282x257	282x257	282x257	282x257
Bath depth	(mm)	180	220	220	220	220	220
Usable liquid depth	(mm)	140	180	180	180	180	180
Height to top of bath	(mm)	900	900	900	900	900	900
Floor area (W x D)) (H)	(mm)	550x735 1250	550x735 1250	550x735 1250	1000x735 1250	1000x735 1250	1000x735 1250
Weight	(Kg)	185	195	175	175	295	300
Supply	(V;Hz)	230; 50	230; 50	230/400; 3/N/PE 50 (Protection class 1 to VDE 106)			
Loading	(kW)	3.2	3.5	3.9	3.7	5.3	5.1
		Units conform to EU Guideline 89/336/EWG (EMC) and 73/23/EWG (low-voltage) and carry the CE mark (50 Hz units)					
Cat.-Nr.							
Simplex-Pump		**LUK 117**	**LUK 137**	**LUK 201**	**LUK 203**	**LUK 205**	**LUK 207**
Duplex-Pump		**LUK 118**	**LUK 138**	**LUK 202**	**LUK 204**	**LUK 206**	**LUK 208**

Units with different voltages may have a different loading (see unit label) !

*) see item 4.3

Technical changes reserved!

Type		**RUK 50-P**	**RUK 50 W-P**	**RUK 90-P**	**RUK 90 W-P**
Working temperature range	(°C)	-40...100	-40...100	-80...100	-80...100
Ambient temperature range	(°C)	5...35	5...35	5...35	5...35
Condenser cooling		Air	Water	Air	Water
Temperature setting/resolution	(°C)	membrane keypad with 16 keys, setpoint input with 0.01°C resolution			
Bath temperature measurement		built-in digital thermometer with 0.01°C resolution, accuracy and stability of measurement (electronics without probe) better than 0.05 % ± 0.05 K *). Temperature probe Pt 100 to DIN IEC 751, Class B, can be calibrated additively at each measurement point.			
Display		back-lit LCD matrix display, 2 lines with 16 signs each, 10 mm character height			
External temperature measurement		2 separate temperature measurement circuits for external Pt 100 to DIN IEC 751 in 4-wire circuit, accuracy and stability of measurement better than 0.05% ± 0.05 K *), can be calibrated additively at each measurement point. One probe produces the measurement for external control.			
Temperature control		modified PID/PI controller with automatic structure selection. Control parameters through auto-adaptation or manual input. With external control a cascade controller operates on the measurement of one of the external circuits (T1 or T2)			
Temperature variation (at –10°C)	(±°C)	0.02...0.05*)	0.02...0.05*)	0.02...0.05*)	0.02...0.05*)
Heater rating, max.	(kW)	2.0	2.0	2.0	2.0
Cooling capacity (eff.): (with ethanol at 20°C ambient temperature) 20°C	(KW)	2.3	2.8	1.5	1.8
0°C		2.0	2.3	1.2	1.4
–10°C		1.8	2.0	1.1	1.3
–20°C		1.2	1.2	1.0	1.2
–40°C		0.2	0.2	0.9	1.0
–50°C		----	----	0.8	0.9
–60°C		----	----	0.6	0.7
–80°C		----	----	0.1	0.1
Safety system		Overtemperature protection with selectable switch-off point, low-level protection to EN 61010 FL (DIN 12879 Class 2)			
Simplex pump					
Pump output against zero head	(l/min)	50	50	50	50
max. pump pressure	(bar)	0,8	0,8	0,8	0,8
Pump connections		M 19x1,5; Nipples 15 Ø	M 19x1,5; Nipples 15 Ø	M 19x1,5; Nipples 15 Ø	M 19x1,5; Nipples 15 Ø
Filling volume, max	(L)	19...27	19...27	19...27	19...27
Bath opening (W x D)	(mm)	282x257	282x257	282x257	282x257
Bath depth	(mm)	220	220	220	220
Usable liquid depth	(mm)	180	180	180	180
Height to top of bath	(mm)	900	900	900	900
Floor area (W x D)	(mm)	550x735	550x735	1000x735	1000x735
(H)		1250	1250	1250	1250
Weight	(Kg)	175	175	295	300
Supply	(V;Hz)	230/400; 3/N/PE 50 (Protection class 1 to VDE 106)			
Loading	(kW)	4,1	3,9	5,5	5,3
		Units conform to EU Guideline 89/336/EWG (EMC) and 73/23/EWG (low-voltage) and carry the CE mark (50 Hz units).			
Cat.-No.		**LUK 231**	**LUK 227**	**LUK 229**	**LUK 230**

Units with different voltages may have a different loading (see unit label) !

*) see item 4.3

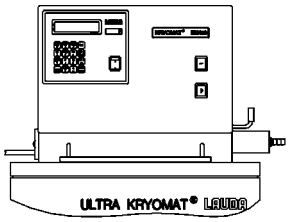
Technical changes reserved!

Type		**RUK 40 S**	**RUK 40 SW**	**RUK 90 S**	**RUK 90 SW**
Working temperature range	(°C)	-40...100	-40...100	-90...100	-90...100
Ambient temperature range	(°C)	5...35	5...35	5...35	5...35
Condenser cooling		Air	Water	Air	Water
Temperature setting/resolution	(°C)	membrane keypad with 16 keys, setpoint input with 0.01°C resolution			
Bath temperature measurement		built-in digital thermometer with 0.01°C resolution, accuracy and stability of measurement (electronics without probe) better than 0.05 % ± 0.05 K *). Temperature probe Pt 100 to DIN IEC 751, Class B, can be calibrated additively at each measurement point.			
Display		back-lit LCD matrix display, 2 lines with 16 signs each, 10 mm character height			
External temperature measurement		2 separate temperature measurement circuits for external Pt 100 to DIN IEC 751 in 4-wire circuit, accuracy and stability of measurement better than 0.05% ± 0.05 K *), can be calibrated additively at each measurement point. One probe produces the measurement for external control.			
Temperature control		modified PID/PI controller with automatic structure selection. Control parameters through auto-adaptation or manual input. With external control a cascade controller operates on the measurement of one of the external circuits (T1 or T2)			
Temperature variation (at –10°C)	(±°C)	0.1...0.5 *)	0.1...0.5 *)	0.1...0.5 *)	0.1...0.5 *)
Heater rating, max.	(kW)	2.0	2.0	2.0	2.0
Cooling capacity (eff.): (with ethanol at 20°C ambient temperature) 20°C	(KW)	4.8	6.0	4.0	4.0
0°C		3.9	4.8	3.6	3.6
–10°C		3.0	3.8	3.4	3.4
–20°C		2.0	2.4	3.2	3.2
–40°C		0.7	0.8	2.8	2.8
–50°C		----	----	2.0	2.0
–60°C		----	----	0.7	0.7
–80°C		----	----	0.2	0.2
Safety system		Overtemperature protection with selectable switch-off point, low-level protection to EN 61010 FL (DIN 12879 Class 2)			
Simplex pump					
Pump output against zero head	(l/min)	50	50	50	50
max. pump pressure	(bar)	0.8	0.8	0.8	0.8
Pump connections		M 19x1.5; Nipples 15 Ø	M 19x1.5; Nipples 15 Ø	M 19x1.5; Nipples 15 Ø	M 19x1.5; Nipples 15 Ø
Filling volume, max	(L)	19...27	19...27	19...27	19...27
Bath opening (W x D)	(mm)	282x257	282x257	282x257	282x257
Bath depth	(mm)	220	220	220	220
Usable liquid depth	(mm)	180	180	180	180
Height to top of bath	(mm)	900	900	1060	1060
Floor area (W x D)	(mm)	1000x735	1000x735	1300x735	1300x735
(H)		1250	1250	1410	1410
Weight	(Kg)	260	260	440	440
Supply	(V;Hz)	230/400; 3/N/PE 50 (Protection class 1 to VDE 106)			
Loading	(kW)	6.1	5.7	9.1	8.7
		Units conform to EU Guideline 89/336/EWG (EMC) and 73/23/EWG (low-voltage) and carry the CE mark (50 Hz units).			
Cat.-No.		**LUK 209**	**LUK 210**	**LUK 211**	**LUK 212**

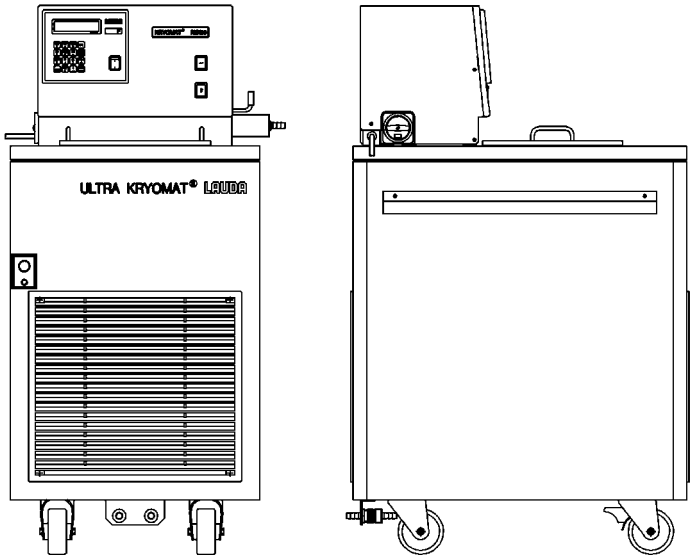
Units with different voltages may have a different loading (see unit label) !

*) see item 4.3

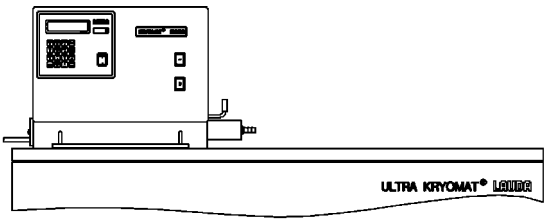
Technical changes reserved!

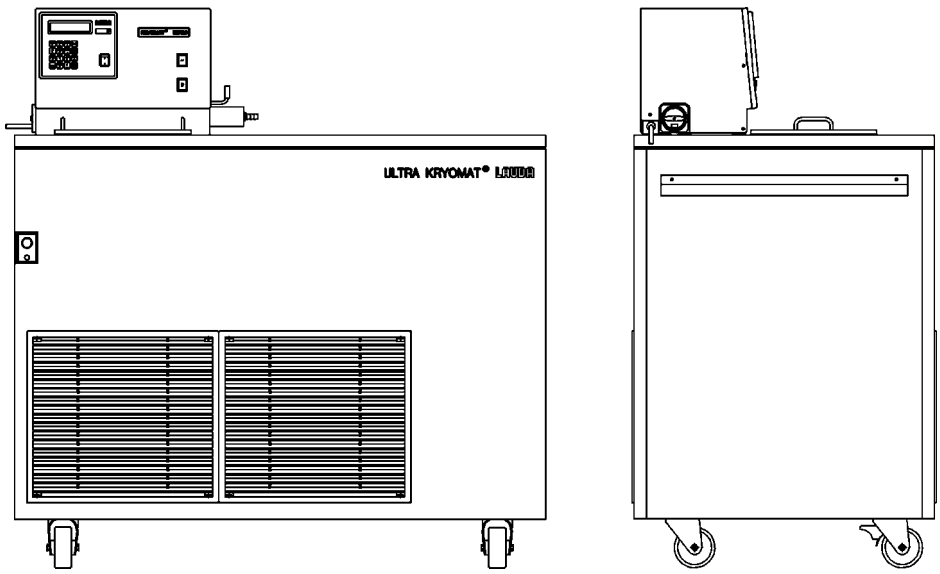


RUK 50-P
RUK 50 W-P

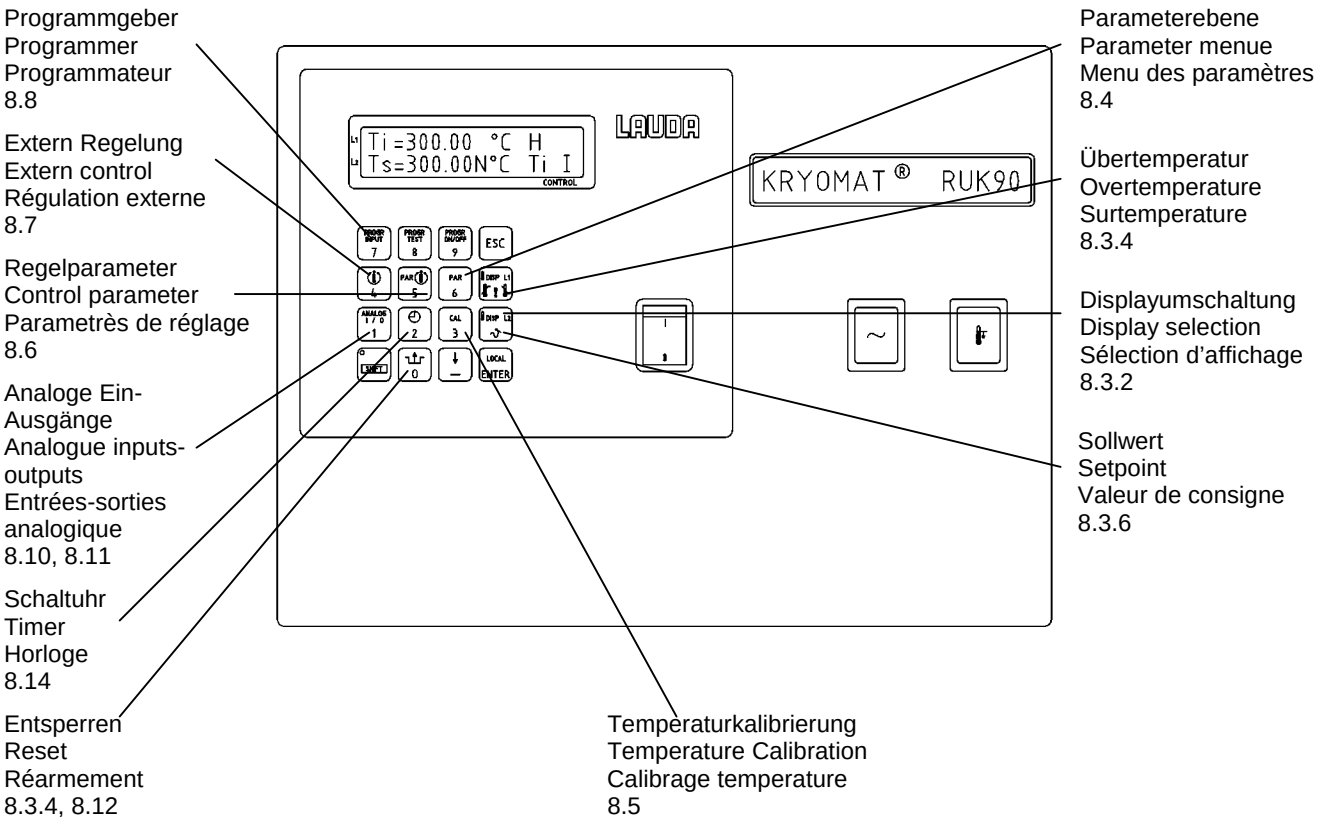


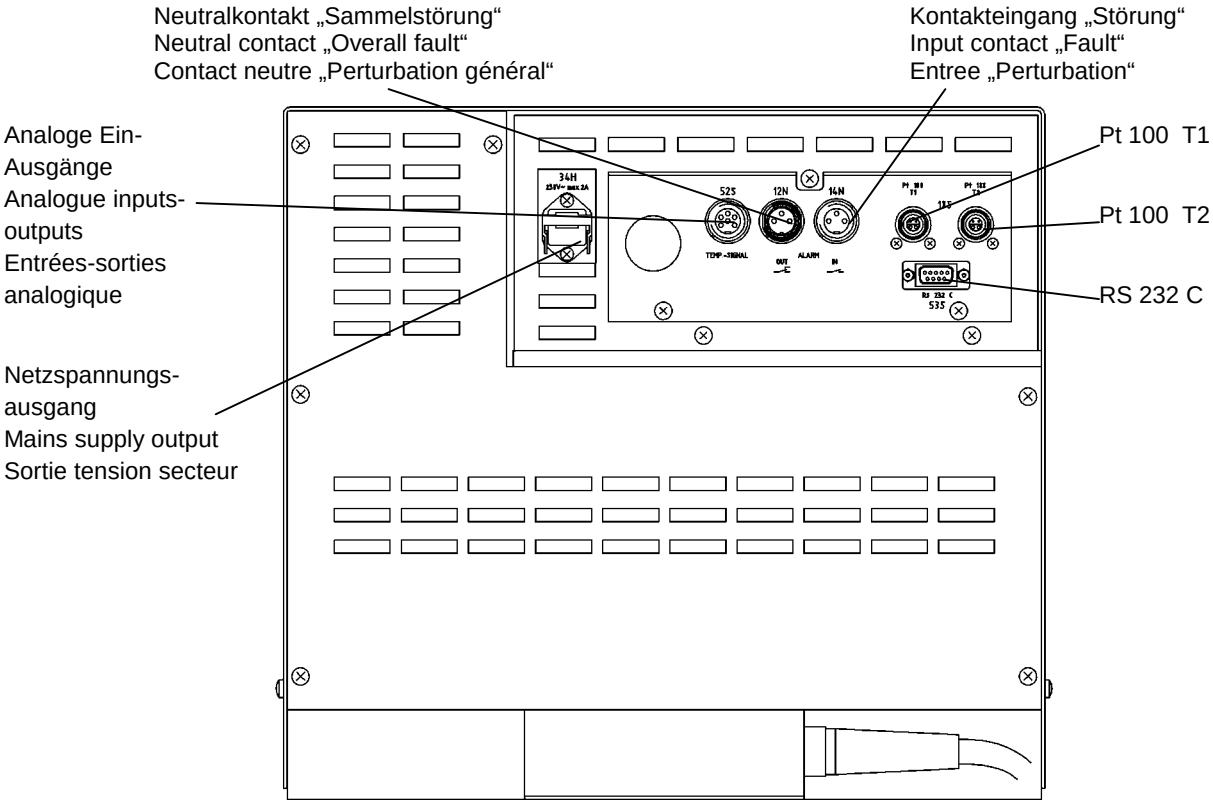
RUL 80 (-D)
RUL 90 (-D)
RUK 50 (-D)
RUK 50 W (-D)





RUK 40 S
RUK 40 SW
RUK 90 S
RUK 90 SW
RUK 90-P
RUK 90 W-P
RUK 90 (-D)
RUK 90 W (-D)


Programmgeber
Programmer
Programmateur
8.8
Extern Regelung
Extern control
Régulation externe
8.7
Regelparameter
Control parameter
Parametrès de réglage
8.6
Analoge Ein-
Ausgänge
Analogue inputs-
outputs
Entrées-sorties
analogique
8.10, 8.11
Schaltuhr
Timer
Horloge
8.14
Entsperren
Reset
Réarmement
8.3.4, 8.12
Parameterebene
Parameter menue
Menu des paramètres
8.4
Übertemperatur
Overtemperature
Surtemperature
8.3.4
Displayumschaltung
Display selection
Sélection d'affichage
8.3.2
Sollwert
Setpoint
Valeur de consigne
8.3.6
Temperaturkalibrierung
Temperature Calibration
Calibrage temperature
8.5
Ti=300.00 °C H
Ts=300.00N°C Ti I
CONTROL
LAUDA
KRYOMAT® RUK90
ESC


Neutralkontakt „Sammelstörung“
Neutral contact „Overall fault“
Contact neutre „Perturbation général“
Kontakteingang „Störung“
Input contact „Fault“
Entree „Perturbation“
Analoge Ein-
Ausgänge
Analogue inputs-
outputs
Entrées-sorties
analogique
Netzspannungs-
ausgang
Mains supply output
Sortie tension secteur
Pt 100 T1
Pt 100 T2
RS 232 C
34H
52S
12N
14N
TEMP.-SIGNAL
ALARM
RS 232 C
535

3 General construction and technical description

3.1 Operating principle

LAUDA Ultra-Kryomats® with Electronics P are bath/circulation thermostats. They differ in bath volume, bath depth, pump type and output as well as in cooling capacity and working temperature range.

Laboratory thermostats operate with liquids (operating medium, heat transfer oil) which serve for energy transfer to the product to be thermostated.

The thermostated products can be immersed in the thermostatic bath (bath thermostat), or placed in an external open bath whose liquid is circulated by the pump of the thermostat.

When operating as circulator the thermostatic liquid is pumped through an external heat exchanger arranged by the user in which a product is being thermostated (jacketed vessels, reactors, heat exchangers).

3.2 Type selection

Ultra-Kryomats® RUL 80 and RUL 80-D have a working temperature range down to -80°C, Ultra-Kryomats® RUL 90 and RUL 90-D have a working temperature range down to -90°C and are available only with air-cooled condenser.

Series RUK 50 and RUK 90 are more powerful units and are available with both air-cooled and water-cooled condenser. Version RUK-P is equipped with a more powerful Simplex pump and has a slightly restricted temperature range.

Series RUK 40 S and RUK 90 S have an appreciably larger cooling capacity combined with the high-power Simplex pump.

3.3 Construction

The refrigeration system is mounted in the lower part of the basic unit. Above this the rust-free stainless steel bath is set into the cover plate. On RUL 80, RUL 90 and RUK 90 units a heat exchanger embedded in insulation is located below the cover plate. The main constructional element is a frame made up from rolled sections and fitted with covers on all four sides. The unit is mounted on four castors, the two front ones of them can be locked. Front and rear panels are fitted with large ventilation grills which ensure heat dissipation, especially in air-cooled units. The side panels have recessed hand rails so that the units can be placed side by side. The back of the cover plate carries the control unit with pump drive, electrical controls, connections for temperature probe, level probe and heater, as well as the control panel with electronics and connection to the supply.

3.4 Thermostatic bath

The bath is made of rustfree stainless steel and insulated with polyurethane foam to suit the working temperature. Most of the bath area has a free bath opening for thermostating inside the bath. All parts in contact with the bath liquid are made from rustfree stainless steel, nickel-plated copper, plastics stable over the working temperature range (PETP) or PTFE.

3.5 Circulating pump

The units are fitted either with a pressure pump (type designation without -D or with -P) which we call SIMPLEX pump, or with a pressure/suction pump with level control (type designation with -D) called DUPLEX pump. Both pump types are submersible centrifugal pumps.

Simplex pumps have a single pressure stage; they are used for thermostating closed external systems or when the unit is used mainly as a bath thermostat.

Duplex pumps have a pressure stage and a suction stage. The output of the pressure stage is adjusted by a float in accordance with the bath level so that the two stages have the same output. This arrangement permits to thermostate open external baths.

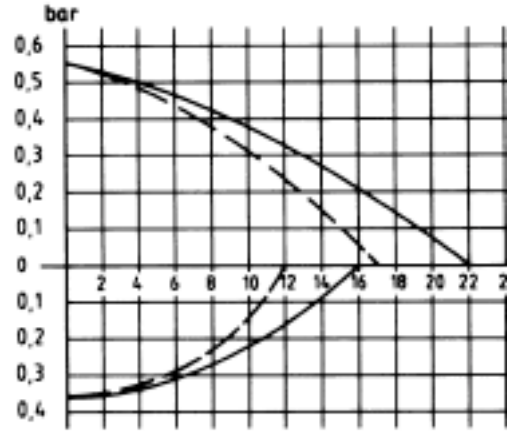
The pumps are fitted with a lever for flow rate adjustment which can be used to vary the flow rate between zero and the maximum. The pumps operate perfectly up to a viscosity of approx. 150 mm^2/sec, with the pump output decreasing rapidly with increasing viscosity.

Pump characteristics
50 Hz, water

SIMPLEX pump RUL 80, RUL 90, RUK 50 (W), RUK 90 (W)

nipple 13 mm dia.
nipple 11 mm dia.
measured according to DIN 58966

DUPLEX pump RUL 80-D, RUL 90-D, RUK 50 (W)-D, RUK 90 (W)-D



nipple 13 mm dia.
nipple 11 mm dia.
measured according to DIN 58966

SIMPLEX pump RUK 50 (W)-P, RUK 90 (W)-P, RUK 40 S (W), RUK 90 S (W)

measured according to DIN 58966

3.6 Temperature control and electronics

The units operate with a Pt 100 resistance thermometer for measuring the bath temperature (T_i). The bath temperature, all other temperature values and message signals as well as inputs are indicated as 2 x 16 characters (10 mm high) on a liquid crystal display (LCD) with background illumination. The input of the setpoint (T_S) and all other parameters is made by using a membrane keypad with 16 keys and the operator guidance in the LCD display field. All inputs are stored even when the thermostat is switched off or if the supply fails.

The digitizing of the Pt 100 resistance signal is performed in the microprocessor by continuous comparison with the precision resistors. The secondary control using a modified PID control algorithm is purely digital. Then the tubular heating element for the heating of the bath is operated electronically using a triac with burst firing action.

The refrigeration units are switched by the electronically controlled auto-compressor system. The LAUDA proportional cooling system uses low-noise solenoid valves to control the cooling action through the PID temperature controller. This leads to minimum energy demand and minimum environmental heating in fully automatic operation over the entire working temperature range under variable load conditions.

3.7 Refrigeration system

The units operate with compressor cooling. Types RUK 50 and RUK 40 S have single-stage systems, types RUL 80, RUL 90, RUK 90 and RUK 90 S have 2-stage systems in cascade. The low-temperature stage operates with an electronic starting control. Depending on the preceding operation the low-temperature stage starts up 10 sec to 20 min after the refrigeration system has been started up.

The refrigeration system cools the bath liquid through a heat exchanger mounted inside the bath.

3.7.1 Air-cooled version

Condenser and motor heat are removed through a finned condenser cooled by a powerful fan. Fresh air is drawn in at the front of the unit and discharged towards the back. It is essential that there is no restriction to free ventilation. Because of this the distance between the ventilation grilles and walls or similar must be at least 0.5 m. Furthermore the units should also not be operated close to sources of heat (such as radiators etc.). The cooling capacity specified under technical data refers to 20°C ambient temperature; higher temperatures lead to a reduction in cooling capacity. Above 35°C the compressor switches off automatically depending on the loading. The heat dissipated to the room air is made up of the heat removed from the bath by cooling together with the energy taken from the electrical supply.

3.7.2 Water-cooled version

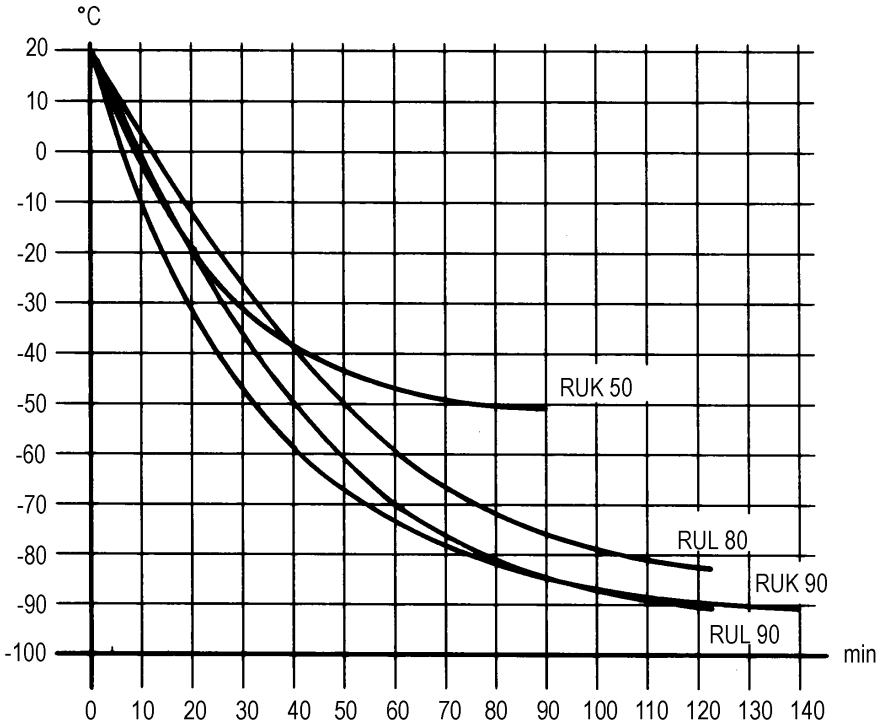
The heat of the condenser and of the motor is removed through a water-cooled counter-flow heat exchanger. The connections for inlet (from the water tap) and outlet (to the drain) are located at the back of the unit underneath the back panel; the inlet on the left and the discharge to the drain on the right when looking at the unit from the back. The cooling water flow is adapted to the demand through the condenser pressure; it is between 30 and 400 l/h depending on the unit type and the operating status. The temperature of the water should not exceed 25°C.

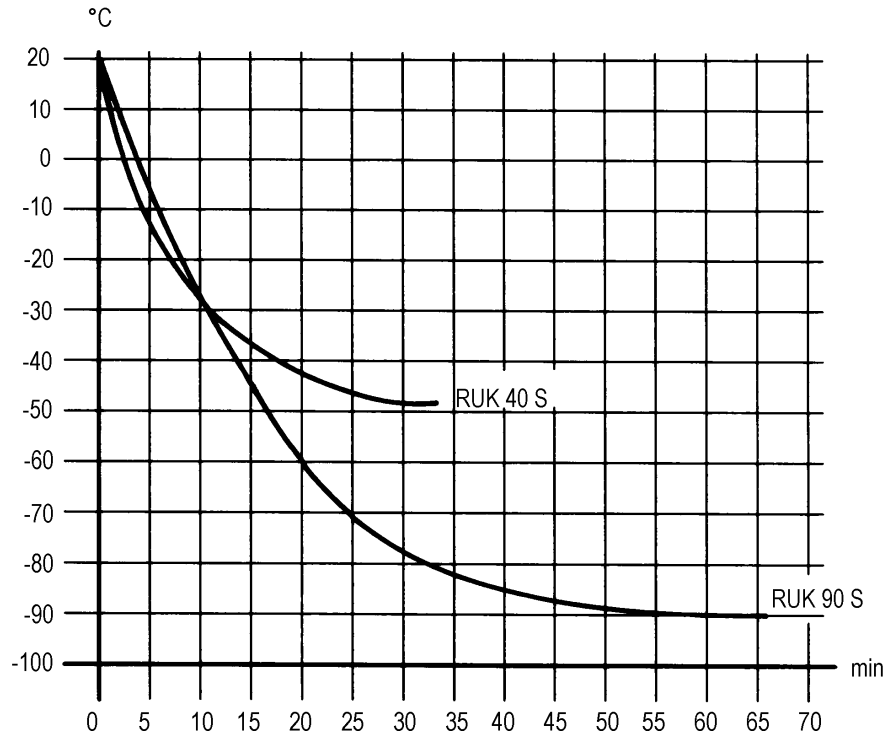
3.7.3 Safety devices of the refrigeration system

The compressors are fitted with an over-temperature cut-out which responds to the compressor temperature and to their current consumption. In addition the cooling systems are protected against over-pressures by pressure control devices.

When the refrigeration compressor (or both compressors) is in operation the green lamp  in the control unit is alight.
If this signal lamp is not alight despite the fact that the controller demands cooling (cooling symbol on the right of the display) please check whether the finned condenser is dirty (air cooled units) or whether there is a fault in the water supply or discharge (water-cooled units).

3.7.4 Cooling diagrams





Bath liquid: ethanol

3.8 Mains supply output 34 H

The 230 V supply voltage is available at the socket 34 H at the back in normal operation and with the unit switched on. The maximum current which can be drawn there is 2 A. In case of a fault this supply is switched off. This output can be used e.g. to connect a non-return fitting (Cat. No. UD 125).

Suitable mating plug Cat. No. EQS 045

3.9 Remote operation (FBK) (option)

As an option the units can be converted to remote control; then the entire electronics with control panel is removed from the unit and used for remote operation. An adapter for the cable connections is required on the basic unit, and the control panel is placed in an extra housing. The conversion is to be carried out by a qualified electrician only. All necessary components except the connection cables are supplied as part of the kit.

Please specify the length of the connecting cables. See accessories in the Appendix.

4 Safety devices and warning notes

4.1 Safety functions

The built-in over-temperature limiter can be set over the complete operating temperature range.

The bath temperature is measured by a separate Pt 100 resistance sensor (T_{Si}) and processed by a separate analogue/digital converter. This measured value is compared with the measured value of the bath temperature probe (T_i) continuously. If the measurements differ by more than ±15°C the thermostat switches off as in the case of a low-level or over-temperature fault.

The function of the microprocessor is monitored by an integrated watchdog circuit and an additional counter which operates similarly to a normal watchdog circuit but is also capable of switching off the unit in case of a strobe failure.

When the set overtemperature switch-off point (T_O) is exceeded the unit switches off permanently on all poles.

A float switch with magnetic coupling acts as a low-level cut-out and also switches off the unit (pump, heater and cooling system) permanently on all poles.

In both fault conditions the display shows the corresponding message, and additionally an audible signal draws attention to the fault. The switch-off function of the safety circuit remains stored even during a break in the supply or after having switched off the supply.

Reset is possible by pressing the reset key  , but only after having eliminated the toubles.

The pump motor is fitted with a temperature monitor which switches off if the motor winding overheats. The heater is also switched off simultaneously. After the motor winding has cooled down the pump starts up automatically.

4.2 Why can a thermostat be dangerous?

1. Thermostats are equipped with heaters supplying the necessary heat to the thermostating liquid. If the temperature control fails or if the liquid level is too low, the heater may reach temperatures which can lead to a fire in the laboratory, especially in combination with flammable liquids.

2. When using the thermostat as a circulation thermostat a hose may break, causing hot liquid to spill and endangering people and goods.

The safety requirements on thermostats therefore depend on whether

- non-flammable or flammable liquids are used
- operation is with or without supervision.

The thermostats described in these Operating Instructions are protected against overtemperature and low liquid level when operated according to the regulations (FL).

The units can be operated with non-flammable bath liquids and with flammable bath liquids up to 25°C below their fire point (EN 61010) on condition that there is a correct adjustment and regular testing (see Item 8.12) of overtemperature and low-level protection.

4.3 Important notes

The user is only protected against those hazards which are caused by exceeding the temperature and by low liquid level.

Further hazards may arise from the type of product being thermostated, e.g. a shift above or below certain temperature levels or a fracture of the container and a reaction with the thermostatic liquid etc.

It is impossible to cover all possible causes, and they remain largely within the decision and responsibility of the user.

Values for temperature variation and indication accuracy apply under normal conditions according to DIN 58966. In special cases high-frequency electromagnetic fields may lead to less favourable values. There is no loss of safety.

Units are in accordance with EMC directive EN 61326-1, class A *:
Units are only suitable for use in industrial areas as disturbing voltage fluctuations might occur.

* Notice only valid for EU countries

Warning: The units must only be used according to the descriptions indicated in these Operating Instructions.

This includes operation by properly qualified and instructed personnel.

The units are not designed for operation under medical conditions according to EN 60601-1 or IEC 601-1!

4.4 Warning notes

4.4.1 Temperatures

The outflow and return pipes of the pumps reach the operating temperature, i. e. even temperatures above 70°C. Touching them is dangerous because of very high or low temperatures!

4.4.2 Mains connection

Connect the unit only to mains sockets with protective earth contact (PE). They must have a fuse according to the unit label.

4.4.3 Fume extraction

Depending on the bath liquid used and the operating method there is a possibility that toxic vapours may be produced. In that case it is necessary to provide an appropriate fume extraction. Pull out the mains plug before cleaning the bath with solvents. Provide appropriate fume extraction. Before starting up the unit it is absolutely essential to ensure that the bath contains no explosive mixtures. If necessary purge it with nitrogen!

5 Bath liquids and hose connections

The operating ranges of the bath liquids and hoses are general information only and may be restricted through the operating temperature range of the units or safety requirements specified in the appropriate standards (see Item 4.2).

5.1 Bath liquids

LAUDA Designation		Working temperature range	Chemical Designation	Viscosity (kin)	Viscosity (kin) at Temperature	Fire-point	Ref.No. Quantity		
	Former designation	from °C to °C	at 20°C	mm²/s	mm²/s		5 l	10 l	20 l
	water	5...90	deionised water ①	--	--	--			
Kryo 20	160 MS	-20...+180	Silicone oil	11	28 at -20°C	> 230	LZB 116	LZB 216	LZB 316
Kryo 30 ②	G 100 ②	-30...+90	Mono-ethylene-glycol/water	4	50 at -25°C	--	LZB 109	LZB 209	LZB 309
Kryo 51	---	-50...+120	Silicone oil	5	34 at -50°C	> 160	LZB 121	LZB 221	LZB 321
Kryo 60	SK Frigor	-60...+80	Silicone oil	3	25 at -60°C	> 110	LZB 102	LZB 202	LZB 302
Kryo 85	Ultra-Therm XLT	-85...+30	Silicone oil	1.76	17 at -80°C	> 56	LZB 113	LZB 213	LZB 313

① At higher temperatures → Evaporation losses → Use bath covers (⩾ Section 10. Accessories). Distilled water or fully deionised water must only be used with the addition of 0.1g sodium carbonate (Na_2CO_3) /l water, otherwise→ danger of corrosion!

1. Water content falls after prolonged operation at higher temperatures
   → mixture becomes flammable (flash point 128 °C).
   → Check the mixture ratio with a densitometer.

– When selecting bath liquids it should be noted that performance must be expected to worsen at the lower limit of the operating temperature range due to increasing viscosity. The full operating range should only be utilised if really necessary.

– The operating ranges of the bath liquids and tubing represent general data which may be limited by the operating temperature range of the unit.

Silicone oil causes pronounced swelling of Silicone rubber → never use Silicone oil with Silicone tubing!

Ethyl alcohol
Ethyl alcohol is frequently used for operating temperatures below -60°C.

Warning As the fire point of ethyl alcohol is 12°C the user works outside the standard specifications (see Item 4.2). It is essential that the unit is being operated under continuous supervision.

boiling point	78°C	fire point	12°C
viscosity at 20°C	1,5 mm²/s	freezing point	-114°C

DIN safety data sheets are available on request!

5.2 Hose connections (continuous lengths)

Tubing type	Int. dia. Ø mm	Temperature range °C	Application	Ref. No.
EPDM-tubing uninsulated	9	10...120	For all bath liquids; except Ultra 350 and mineral oils	**RKJ 111**
EPDM-tubing insulated	9	-60...120	For all bath liquids; except Ultra 350 and mineral oils	**LZS 019**
EPDM-tubing uninsulated	12	10...120	For all bath liquids; except Ultra 350 and mineral oils	**RKJ 112**
EPDM-tubing insulated	12 ext. dia. 35mm approx	-60...120	For all bath liquids; except Ultra 350 and mineral oils	**LZS 021**
Silicone tubing, insulated	8 ext. dia. 30 mm approx	-60...100	water, water/glycol mixture	**LZS 001**
Silicone tubing, insulated	8 ext. dia. 50 mm approx	-100...100	water, water/glycol mixture	**LZS 002**
Silicone tubing, uninsulated	8	10...100	water, water/glycol mixture	**RKJ 016**
Silicone tubing, uninsulated	11	10...100	water, water/glycol mixture	**RKJ 059**
Silicone tubing, insulated	11 ext. dia. 32 mm approx	-60...100	water, water/glycol mixture	**LZS 007**
Silikonschlauch insulated	11 ext. dia. 52 mm approx	-100...100	water, water/glycol mixture	**LZS 009**
Silikonschlauch uninsulated	14	10...100	water, water/glycol mixture	**RKJ 070**
Silicone tubing, insulated	14 ext. dia. 35mm approx	60...100	water, water/glycol mixture	**LZS 011**
Silikonschlauch insulated	14 ext. dia. 55mm approx	-100...100	water, water/glycol mixture	**LZS 012**

- EPDM-tube not for Ultra 350 and mineral oils!
- Silicone oil causes pronounced swelling of Silicone rubber → never use Silicone oil with Silicone tubing!
- Protect tubing with hose clips against slipping off..

Metal hoses single-layer insulation	Tube connection	Ø i (mm)	Ø a (mm)	Temperature range °C	Length	Ref. No.
MC 50	M 16x1	10	18	-10...400	50	**LZM 040**
MC 100	M 16x1	10	18	-10...400	100	**LZM 041**
MC 150	M 16x1	10	18	-10...400	150	**LZM 042**
MC 200	M 16x1	10	18	-10...400	200	**LZM 043**
Pump link	M 16x1	10	18	-10...400	20	**LZM 044**

Metal hoses with insulation	Tube connection	Ø i (mm)	Ø a (mm)	Temperature range °C	Length	Ref. No.
MK 50	M 16x1	10	44	-90...150	50	**LZM 052**
MK 100	M 16x1	10	44	-90...150	100	**LZM 053**
MK 150	M 16x1	10	44	-90...150	150	**LZM 054**
MK 200	M 16x1	10	44	-90...150	200	**LZM 055**
Pump link	M 16x1	10	44	-90...150	20	**LZM 045**

Metal hoses with Insulation	Tube connection	Ø i (mm)	Ø a (mm)	Temperature range °C	Length	Ref. No.
MGK 50	M 19x1,5	12	36	-90...150	50	**LZM 056**
MGK 100	M 19x1,5	12	36	-90...150	100	**LZM 057**
MGK 150	M 19x1,5	12	36	-90...150	150	**LZM 058**
MGK 200	M 19x1,5	12	36	-90...150	200	**LZM 059**

Metal hoses with triple insualtion	Tube connection	Ø i (mm)	Ø a (mm)	Temperature range °C	Length	Ref. No.
MC 50 S	M 16x1	10	34	-60...350	50	**LZM 046**
MC 100 S	M 16x1	10	34	-60...350	100	**LZM 047**
MC 150 S	M 16x1	10	34	-60...350	150	**LZM 048**
MC 200 S	M 16x1	10	34	-60...350	200	**LZM 049**

Further details on thermostatic liquids and hoses can be found in our special publication.

6 Unpacking, assembly and setting up

6.1 Unpacking

Goods are packed carefully, largely preventing transport damage. If unexpectedly some damage is visible on the equipment please inform the carrier or the postal authority so that it can be inspected.

Standard accessories RUL 80 (-D), RUL 90 (-D)

1 Bath cover	Cat. No. HDQ 051
2 Nipples 13 mm dia. (fitted)	Cat. No. HKO 026
2 Nipples 11 mm dia.	Cat. No. HKO 025
1 m Silicone tubing 11 mm int. diameter	Cat. No. LZS 007

Operating Instructions

Standard accessories RUK 50 (W-D), RUK 90 (W-D)

1 Bath cover	Cat. No. HDQ 050
2 Nipples 13 mm dia. (fitted)	Cat. No. HKO 026
2 Nipples 11 mm dia.	Cat. No. HKO 025
1 m Silicone tubing 11 mm int. diameter	Cat. No. LZS 007
2 pces. of 1/2" water hose, 4 m long each, with quick-connect coupling (only with water-cooled units)	

Operating Instructions

Standard accessories RUK 50 (W)-P, RUK 90 (W)-P, RUK 40 S(W), RUK 90 S(W)

1 Bath cover	Cat. No. HDQ 050
2 Nipples 15 mm dia. (fitted)	Cat. No. HKA 005
1 m Silicone tubing 14 mm int. diameter	Cat. No. LZS 011
2 pces. of 1/2" water hose, 4 m long each, with quick-connect coupling (only with water-cooled units)	

Operating Instructions

6.2 Setting up, operation as bath thermostat

Set up the unit conveniently so that the control panel is towards the front, and ensure that the air circulation for the refrigeration system through the grille in the lower part of the unit is not restricted. At air-cooled units a minimum spacing of 50 cm between grille and wall is recommended (see Item 3.7.1).

At water-cooled units (W in type designation) make the hose connections to the water tap and the drain (see Item 3.7.2).

Protect tubing with hose clips against slipping off!

Close the drain cock at the back of the bath!

If no external system is connected it is advisable to link together the pump connections with a piece of hose. The pump control lever should be set to "open", this improves the circulation inside the bath. As a permanent arrangement the hose link (Cat. No. LZM 045 or LZM 056) is the best and safest solution.

7 Connection of external systems

7.1 Connection to closed external systems

Additional liquid must be poured in after the thermostat has been switched on until the liquid in the bath remains at the correct level (approx. 2 cm below the plastic cover plate). For suitable tubing materials please see Section 5. With external systems at a higher level it may happen even in closed systems that the external volume drains down and the thermostat bath overflows if the pump is stopped and air enters the thermostated system!

7.2 Connection to open external systems (baths)

Hang the hoses into the external bath (protect them against slipping out), preferably at two opposite sides. The suction hose should have a notch at its end so that it cannot attach itself by suction to the wall or bottom. Before switching on the unit the external bath has to be filled with liquid up to the required level. If the Kryomat and external bath are not at the same level the connecting hoses have to be vented by pulling them out after the Kryomat has been switched off, in order to prevent overflowing.

Always ensure the maximum possible flow area in the external system (nipples, tubing, system). This results in a larger flow and therefore improved thermostatic control.

Always protect the tubing with hose clips against slipping off, or use stainless steel hoses (V2A) with screwed connections.

7.3 Circulating pumps

In principle there is a difference between SIMPLEX pumps, e.g. at RUK 50, RUK 90 W-P, and DUPLEX pumps at e.g. RUK 50-D, RUK 90 W-D.

SIMPLEX pumps are used for operation with closed external systems. They require a pressure-tight external system.

DUPLEX pumps are used mainly with open external systems, such as baths. In contrast to SIMPLEX pumps they have a pressure and a suction stage as well as a float for level control. DUPLEX pumps automatically maintain a constant level in the Kryomat irrespective of the level in the external bath. Liquid is poured into the external bath until a level is achieved in the Kryomat at which the pressure and the suction stage have exactly the same output. If the difference in level between the open external bath and the Kryomat bath is greater than 0.5 m there is the possibility in certain applications that the control range of the level controller is not sufficient.

With a higher (lower) external bath level the suction (pressure) hose should then be clamped off with a tubing clamp to such an extent that a constant level in the bath is obtained at which the pump float is within its control range.

DUPLEX pumps can of course also be used for the connection of closed external systems. They then offer the advantage of the liquid flowing through the external system at virtually no pressure (important for thin-walled glass vessels). When operating with closed external systems or when used as bath thermostat the bath should be filled to the highest possible level (up to 1 cm below the cover plate).

The circulating pumps have a control lever for continuous flow adjustment (pump output) through the external system between 0 and maximum.

8 Starting up

8.1 Filling

Fill the unit with bath liquid to suit the operating temperature, see Section 5. The filling volume is given under Technical data. In general the thermostat has to be filled up to max. 1 cm below the cover plate. When filling an external system by the pump, additional liquid may have to be added during start-up.

8.2 Connection to supply

Connect the unit only to an earthed socket (PE). Compare the details on the label with the mains voltage (see Item 4.4.2).

When working without external system, ensure that the pump connections are linked together (metal hose link Cat. No. LZM 045 or LZM 056).

8.3 Basic functions

8.3.1 Supply switch-on

Switch on the main switch (red/yellow) on the left of the control unit (except RUL 80(-D), RUL 90(-D)), the green signal lamp  lights up.

Switch on the power switch. The green indicating lamp lights up. The display shows consecutively

Fa LAUDA
P-Thermostat

Type RUK 50 — depending on type
V 2.XX Date — and software version

L1 Ti = 20.00°C K — other values depending on
L2 TS = 10.00°C N Ti I — bath temperature and setpoint

Check the direction of the pump rotation! (RUK-P and RUK-S units only)

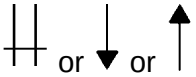
The pump motor has to rotate anticlockwise. When looking at the coupling at the motor shaft end, through the cut-out for the pump control lever or pump connection, the side facing the observer has to rotate anticlockwise. If this is not the case the rotation of the 3-phase current connection is incorrect. The pump does not achieve its full capability. Remedy by interchanging two phases in the supply by a qualified electrician!

Direction of rotation of condenser fan on air-cooled units (without W in the type designation except RUL 80(-D), RUL 90(-D)).

While the refrigerating system is operating the fan draws in air at the front and discharges it at the back. If the pump rotates in the correct direction the fan usually also rotates in the correct direction!

8.3.2 Standard display

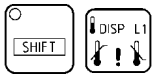
Top line L1

T_i	=	bath temperature (i = internal)
	=	indication of the level in the thermostatic bath crossbeam shows the filling height in the range between min. and max. filling
	=	add additional liquid
	=	max. filling height, heating switches off
C	=	output in cooling range
H	=	output in heating range
	=	cooling indication proportional to cooling actuation control
	=	heating indication proportional to heating actuation control

Bottom line L2

T_S	=	setpoint temperature (S = setpoint)
N	=	notice that the level indication acts in the top line L1
T_i	=	control variable is T_i (bath temperature), can be switched to T_1 or T_2 (ext. Pt 100)

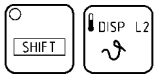
I = setpoint source (I = internal = input by keys,
P = programmer, R = RS 232 C,
A = analogue input socket 52 S)

The display in line 1 (L1) can be switched by pressing the keys 

and repeated operation of 

to T_1, T_2, T_i etc.

T_1, T_2 = measurements of external Pt 100 probes

The display in line 2 (L2) can be switched by pressing the keys 

and repeated operation of 

to

Y = actual output + heating - cooling

T_{Si} = measurement of the safety comparison probe with limited resolution and accuracy

T_i, T_1, T_2, T_S etc.

8.3.3 Basic action on inputs and outputs

From virtually every display or input function the key 

aborts and returns to the selected standard display!

Numerical inputs are always made with the SHIFT function switched off (LED in SHIFT key off) !

After the last digit of a number the cursor returns to the first digit so that corrections can easily be made before pressing the 

key.

A brief beep on pressing a key means that this input is not possible!

Error messages are indicated with text notes and accompanied by a beep. After approx. 5 sec the message disappears and the beep switches off!

8.3.4 Overtemperature switch-off point

Press the DISP L1 key to indicate the current overtemperature switch-off point (TO).

Important: The green LED in the SHIFT key must not be alight. If necessary bring the keypad to the basic mode by pressing the SHIFT key (LED off). If TU is indicated, press DISP L1 again to indicate TO.

L2 TO: _95.00 Ti I

TO = overtemperature switch-off point

TO can be selected within the unit temperature range + 5 K.

Return to the standard display without change with ESC. A new value is input with the number keys (SHIFT OFF); e.g. 98.70°C requires 0, 9, 8, 7, 0 LOCAL ENTER. After the last digit the cursor returns to the first digit again so that any corrections can easily be made. Pressing LOCAL ENTER always enters the value on the display.

It is obviously essential to select a value above the current bath temperature (Ti) and the current setpoint (TS), otherwise the equipment is switched off by the safety circuit with

L1 TEMPERATURE

L2 TOO HIGH!

or the message

L2 TS >> TO

and the value is not accepted.

If the unit was switched off in the fault status an audible signal reports the stored fault when switching on.

Press reset key 0. Depending on the previous sequence press 0 again.

If necessary check whether the overtemperature switch-off point TO is above the current bath temperature and whether the bath is filled sufficiently!

8.3.5 Low temperature switch-off point

Press 

(SHIFT OFF) to indicate the current low temperature switch-off point TU. If TO is indicated, press the key 

again to bring TU on display.

L2 TU: _-10.00°C

TU = low temperature switch-off point

TU can be set up to 10 K below the working temperature range of the unit.

If the bath temperature falls below TU, TU appears on the display in L2 so that a new value can be input if necessary. In addition the refrigeration unit is switched off so that TU can be used e.g. as anti-freeze protection and of course as setpoint limitation!

8.3.6 Setpoint input

Press the key 

(SHIFT LED off). L2 shows

L2 TS: _ 20.00°C Ti I

The setpoint (TS) can be input within the unit temperature range but not higher than the current overtemperature switch-off point. When the input is too high, pressing 

does not enter the value but instead produces the message

L2 TS >> TO

Input TS with the number keys and the negative sign (SHIFT OFF), e.g. for -25.03°C input -, 2, 5, 0, 3 

. Or for 1.93°C input 0, 0, 1, 9, 3. After the last digit the cursor returns to the first digit again so that corrections can easily be made.

8.4 Parameter level PAR

Pressing the key 

several times in the SHIFT mode (green LED in SHIFT key alight) leads successively to the input functions described below.

8.4.1 Auto-adaptation

Here it is possible to start the controller auto-adaptation by input of 1 (SHIFT OFF) and pressing the LOCAL ENTER key.

There should be the largest possible difference between the bath temperature and the setpoint to be entered subsequently; i.e. the time to reach the setpoint has to be longer than 5 min, preferably 10 min. In addition, auto-adaptation is obviously possible only during a heating or cooling phase which is actively influenced by the energy sources available.

Example 1: intended operating temperature approx. 70°C:

1. Set the setpoint to 70°C
2. Within 1 minute start auto-adaptation at the PAR level, e.g. at a bath temperature corresponding to the ambient temperature.

On reaching the setpoint the auto-adaptation switches off automatically, and its result can be indicated at the control parameter level PAR 5 (see Item 8.6).

Example 2: it is required to operate at approx. -20°C with controlled cooling:

1. Set the setpoint to -20°C
2. Start auto-adaptation at the PAR level

8.4.2 Output limitation

Normally the maximum heating or cooling output is available. For special applications it is possible to set a limit for both heating and cooling output.

At the PAR level display select

L1 Output

L2 in per cent_ 100 %

Using ↓ — the display can be switched from e.g. 100%, i.e. heating output limitation, to cooling output limitation with a negative sign.

By the input of e.g. 0, 0, 5, 8 LOCAL ENTER, SHIFT OFF, a heating output limitation of 58% can be set. With e.g. -, 0, 9, 3 LOCAL ENTER a cooling output limitation of 93% is entered. The action can be recognised by the symbols  and  flashing even at large control deviations.

At thermostats with refrigeration system the activation of refrigeration can be suppressed by entering -000%.

Only values between 10 and 100% or -10 and -100% can be entered, otherwise the display shows the message

L1 Output

L2 OUT OF RANGE

8.4.3 Display resolution L1

At the PAR level display select

L1 Display 0.001 = 1

L2 resolution 0.01 = 0

Enter 1 SHIFT OFF, 

. Switches all displays in L1 to 0.001 K resolution. The temperatures are then displayed with approx. 2 digit resolution. Input "0" switches all displays in L1 to 0.01 K resolution. Normally a resolution of 0.01 K is used.

8.4.4 Contact input Fault 14 N

When using the contact input "FAULT" 14 N, pins 1 and 2 of the socket have to be connected together when there is no fault. If this input is not used a blanking plug with a link has to be plugged in. The function of the contact input fault can be switched off at the PAR level when the display shows

L1 Alarm Inp. con 14 N

L2 on = 1 off = 0

by the input of "0" (SHIFT OFF). A shorting plus is not required.

If the alarm input has been activated in error by the input of "1" the unit can be restarted by the following inputs:

Press the key 

. Select "Alarm Inp. con 14 N" at the PAR level. Input "0" with 

. Press 

again.

If a fault message has been produced by opening the external signal circuit, reset by pressing the key 

twice after rectifying the fault.

Connections contact input "Fault" 14 N (alarm in)

3-pin flange socket to NAMUR recommendation NE 28

1 = n.o. (close)
2 = common
3 = not used

Connector plug 3-pin Cat. No. EQS 048

Use shielded connecting cables. Connect the shielding to the plug case. Cover the unused connectors with protective caps!

8.4.5 Baud rate RS 232

On the display at the PAR level

L1 Ser. Int RS 232

L2 Baud Rate 9600

it is possible to switch with 

between 9600 and 4800. With 

(SHIFT OFF) the indicated baud rate is entered.

8.4.6 Menu language

On the display at the PAR level

L1 Lang. Germ = 0

L2 Engl = 1 French = 2

the menu language can be selected. Enter the corresponding code numbers 0, 1 or 2 with 

on SHIFT OFF.

8.4.7 Calibrating the analogue output channels

The 90% values of the analogue voltage outputs channel 1 and 2 or the analogue current output of channel 1 can be calibrated separately for channel 1 (voltage or current) and channel 2 (voltage). The factory calibration on channels 1 and 2 for 0...10 V = -100...400°C is performed at 9 V = 350°C.

In special cases, e.g. to correct scaling deviations of instruments connected to the output, or if channel 1 is to be a current output, the output can be calibrated by the user.

At the PAR level display select

L1 Analogue outp Cal ?

L2 Chan 1 = 1 Chan 2 = 2

Input SHIFT OFF 1 [LOCAL ENTER], or 2 for channel 2.

Depending on the selected configuration of the analogue outputs (see Item 8.11) the socket 52 S (analogue signals, see Item 8.9), pin 2, carries a voltage signal of approx. 95% or 9.5 V, or pin 5 the corresponding current signal of approx. 19 mA in case of current configuration for channel 1.

With a precision multimeter or e.g. a temperature recorder, set the output signal to 9 V or 18 mA or the corresponding temperature by the repeated operation of the key [↓ —] (SHIFT ON). Pressing [ESC] leaves the menu, and the most recent value setting is entered.If the value was selected too low, leave the PAR level with [ESC] and make a new selection.

The calibration of channel 2 is similar. Connect the measuring instrument to pin 1 (voltage signal only).

8.5 Calibration of the temperature measurement circuits

With the calibration function the indications of the three temperature measuring points bath temperature T_i, external Pt 100 probe T_1 and external Pt 100 probe T_2 can be set to a known accurate value. The resulting correction is processed additively over the entire temperature range.

Make sure that a sufficiently accurate reference is available, otherwise it is better to use the factory calibration which gets lost by overwriting!

Pressing the key [CAL 3] in the SHIFT mode (green LED in shift key alight) produces the display

L1 CALIBRATE

L2 $T_i = 0$ $T_1 = 1$ $T_2 = 2$

The channel to be calibrated is selected with 0, 1 or 2 [LOCAL ENTER].

When selecting an unused channel, e.g. if Pt 100 is not connected to T_2, the display shows

L1 Ext Pt 100 not

L2 connected.

For calibration a sufficiently accurate reference temperature measurement should be possible, and the measurement point temperature should be constant.

The display shows

L1 T_1 61.04°C

L2 T_C _ . °C

The value shown in L1 is the measured value obtained without any correction using probe and electronics without calibration.

Now enter the real value for the measurement point T_1 (e.g. 60.00°C).

Example 0, 6, 0, 0, 0 LOCAL ENTER

T_i or T_2 can be calibrated in the same way.

In order to avoid dangerous conditions the correction is limited to ±5 K. In case of larger corrections the display shows

L1 CORRECTION VALUE

L2 TOO LARGE

and the entered value is not accepted.

You can leave the calibration level with ESC.

8.6 Control parameters

8.6.1 Indication and input of the control parameters

Pressing the key PAR 5 several times in the SHIFT mode (green LED in shift key alight) shows the outflow temperature limitation, the correction limitation and the control parameters X_p, T_n and T_v on the display in L2.

Example:

L2	TiO	120°C	Ti	I
L2	Td	_30°C	Ti	I
L2	Xp: _	0.5°C	Ti	I
L2	Tn: _	12.0 s	Ti	I
L2	TV: _	2.0 s	Ti	I

In order to use control parameters other than those found by auto-adaptation (see Item 8.4.1) the values can be entered in the appropriate display after switching off the SHIFT function, pressing 

, LED off.

Example for Xp: 0, 0, 1, 0 

if the required value is 1.0°C.

For values above 200.0°C or 200.0 sec the message

L2 OUT OF RANGE

appears.

8.6.2 Recommendations for the control parameters

In most cases satisfactory control results are obtained with the following control parameters:

bath liquid	water	oil
XP	0.5°C	1°C
Tn	10 s	25 s
TV	2 s	5 s

8.6.3 Bath temperature limitation

The limitation of the bath temperature is an additional warning and switch-off function switching off the heating at a selectable value, i.e. the heating output is set to "0". This protects the unit from a continuous cutoff via the safety circuit especially during external control at certain operating conditions.

To enter the switch-off point TiO proceed as described in Item 8.6.1 and switch the display to input and indication.

Example:

L2 TiO 120°C

Change the value by entering the figures with a resolution of 1°C.

Enter the new value by pressing LOCAL ENTER.

It is possible to select values within a range from 50 °C to the selected overtemperature switch-off point TO -5°C. If this range has not been accepted the display shows the message

L2 TiO >> TO -5°C

Of course TiO has to be set above the setpoint TS; otherwise the display shows the message

L2 TS > TiO

The bath temperature limitation can be switched off by entering

L2 TiO 000

If the bath temperature Ti exceeds the selected switch-off point the display shows

Example:

L2 TiO 120°C

and there is an acoustic signal.

The heater switches off. As soon as the temperature has dropped the unit starts working again.

8.6.4 Correction limitation

During the operation with external control it may be necessary not to exceed the difference between the bath temperature Ti and the measuring point for the external control T1 or T2, e.g. in order to get a smooth heating of the material or the vessel.

Such a limit value can be selected by the variable Td. If the value Td is exceeded the heating or cooling output is set to "0". When this function is activated the time for heating up or cooling down may be extended.

To enter the difference value Td proceed as described in Item 8.6.1, and switch the display to input and indication.

Example:

L2 Td _30°C

Change the value by entering the figures with a resolution of 1°.

Enter the new value by pressing LOCAL ENTER.

It is possible to select values within the temperature range from 5°C to 150°C. If this range has not been respected the display shows

L2 Td OUT OF RANGE

and there is an acoustic signal.

This function can be switched off by entering

L2 Td 000°C

8.7 External control

8.7.1 External measurement inputs and external controller

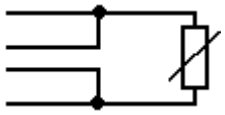
The units have two Pt 100 temperature measurement inputs whose measurements can be indicated (T_1, T_2).

You can connect external Pt 100 (T_1, T_2) at the rear connectors 10 S in 4-wire circuit.

Use shielded connecting cables. Connect the shielding to the plug case. Cover the unused connectors with protective caps!

Pin connections sockets 10 S Pt 100

pin			
1	+	I	current path
2	+	U	voltage path
3	-	U	voltage path
4	-	I	current path



Pt 100
DIN IEC 751

Plug, 4-pin Lemosa, for Pt 100 connection Cat. No. EQS 022

One probe can be selected for the actual value for external control. Then the unit operates with cascade control to this actual value, i.e. the unit controls the temperature at the external measurement point to the selected setpoint by suitably altering the bath temperature.

Thus the influence of disturbances (changes of load or through-flow, etc) can be reduced considerably or eliminated totally.

8.7.2 Start of external control

Connect platinum resistance thermometers to both of the Pt 100 inputs 10 S (T_1 and T_2). It is sensible but not essential to use T_1 if only one input is in use.

The external control with the measuring point T_1 is switched on with the key  in the SHIFT mode; pressing the key again switches to T_2 as control variable.

Pressing the key  once more (SHIFT ON) switches back to the bath control (internal) T_i.

In L2 the position before the final one shows the parameter used as control variable.

L2	TS	= 120.35	Ti	I
			T1	
			T2	

This setting remains stored in case of a fault or after the power is switched off.

If T1 is selected but no probe has been connected the message

L1 Ext Pt 100 not

L2 connected

appears.

The unit then switches the control variable to T_2 automatically. If T_2 is not connected either, the thermostat switches to T_i.

When changing the setpoint for more than 10°C it may be possible to achieve an improved control result by restarting the external control from the control variable T_i (with SHIFT ).

8.7.3 Notes

When operating with external control it is essential to ensure that the probe for the control variable is in good thermal contact with the liquid, otherwise a poor control result must be expected, or the control may be completely ineffective.

Proceeding from the control parameters used for bath control the control may have to be adapted either by auto-adaptation (see Item 8.4.1) or by input of control parameters.

Important: set the overtemperature switch-off point T_O (see Item 8.3.4) sufficiently high since the bath temperature may under certain circumstances become much higher than the setpoint. You may possibly activate the bath temperature limitation as well (see Item 8.6.3).

8.8 Operation with programmer

Temperature programmes with up to 99 segments can be stored and processed. A segment consists of a target temperature which is to be reached at the end of the segment, and the time duration of the segment. The time "00:00" for temperature differences is possible. In connection with the tolerance range monitoring the programme continues not until the target temperature is reached.

It is useful to prepare a time-temperature diagram before programming and to check whether the energy balance enables the programme speed.

Set the overtemperature switch-off point TO to a value slightly above the highest bath temperature to be expected (see Item 8.3.4).

8.8.1 Programme input

Press the key [PROGR INPUT 7] in the SHIFT mode. The display shows

L1 PROG. INP

L2 Tstart:_ . °C

Enter here the starting temperature of the programme. SHIFT OFF (automatically), e.g. for 60.00°C input 0,6,0,0,0 [LOCAL ENTER]. The display shows

L1 PROG. INP SEG.01

L2 T:_ . °C : h

Now enter the target temperature and the time for the first segment, e.g. for 140.00°C in the time 2 h 00 min 1, 4, 0, 0, 0 [LOCAL ENTER] then 0, 2 [LOCAL ENTER] then 0, 0 [LOCAL ENTER].

The display shows

L1 PROG. INP SEG.02

L2 T:_ . °C : h

Now enter the target temperature and the time for the second segment, e.g. for a phase at a constant temperature of 140.00°C and 1 h 30 min.

After the last programme segment press the key 

once more, and the display shows

L1 PROG. INP

L2 NO. OF CYCLES:_

Input 1 ... 99 is possible.

With more than one cycle it is convenient to have the final temperature and the starting temperature T_{start} at the same level!

Afterwards a tolerance range can be input for monitoring the programme.

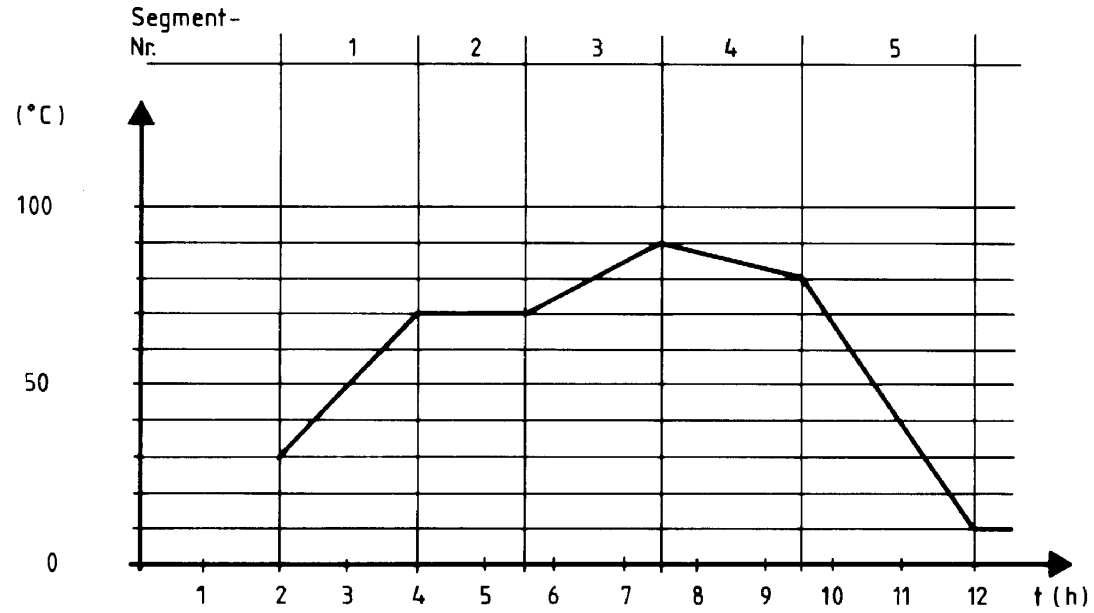
The display shows

L1 PROG. INP

L2 TOL. RANGE_.

Now you can input a tolerance range value from 0.1 to 9.9°C. I.e. if the control variable (bath temperature or external temperature T_1 or T_2) deviates from the set temperature of the segment by more than the tolerance range value while the programme is running, then the programme sequence will be stopped until the control variable is within the tolerance range again. At the same time a "T" appears on the right in L2.
The input of 0.0 switches off the tolerance range function.

8.8.2 Example of a programme



Segment-No.		Input	Press LOCAL ENTER
Tstart		03000	1x
1	°C	7000	1x
	h	02	1x
	min	00	1x
2	°C	7000	1x
	h	01	1x
	min	30	1x
3	°C	9000	1x
	h	02	1x
	min	00	1x
4	°C	8000	1x
	h	02	1x
	min	00	1x
5	°C	1000	1x
	h	02	1x
	min	30	2x
Cycles		1 ... 99	1x
Tolerance range	±°C	(0.0) 0.1...9.9	1x

8.8.3 Programme test

After the input of the programme it is advisable to check that the programme buffer contains the correct data. This is done with the key PROGR TEST 8 in the SHIFT mode. Pressing the key repeatedly produces the same sequence as during the input of the programme.

8.8.4 Changing the programme data

Select the data line to be changed as in "programme test", SHIFT OFF. This resets the data of the indicated segment. Then the data can be input as usual.

Enter the new data with LOCAL ENTER each.

8.8.5 Programme start, interruption and abort

It is convenient to bring the operating temperature of the thermostat to the programme start temperature T_{start} before starting the programme, or to automatize it by the tolerance range function. Start the programme sequence with PROGR ON/OFF 9 in the SHIFT mode. The programme sequence can be followed by the indication of the setpoint T_S.

L_1 shows the segment number on the right, and L_2 shows as a setpoint source a P for "programme" on the right.

The keys 1 to 9 are blocked while the programme is running.

The programme sequence can be stopped with SHIFT PROGR ON/OFF 9 and then be re-started with SHIFT PROGR ON/OFF 9. During the interruption of the programme the display shows a W (wait) on the right in L_2. The programme can be aborted with ESC and then SHIFT PROGR ON/OFF 9 within 2 sec.

Afterwards the programme can only be started with segment 1.

8.9 Connection for analogue signals socket 52 S

6-pin flange socket according to NAMUR recommendation NE 28.

Pin 1: voltage output temperature signal channel 2: setpoint T_S, bath temperature T_i, external Pt 100 T_1 or T_2 can be selected. Scaling can be as follows: 0...10 V corresponding to a temperature range selected within the working temperature range (e.g. 50...80°C) minimum load 4 kOhm or 0...6 V = -200...400°C = 10 mV/K 0°C = 2 V or 0...10 V = -100...400°C or 0...10 V = 0...100°C

Pin 2: voltage output temperature signal channel 1, other data as pin 1

Pin 3: ground for all signals

Pin 4: setpoint voltage input; scaling can be selected as pin 1. R_i = 12 kOhm approx. (+ pin 4; - pin 3)

Pin 5: current output temperature signal channel 1; signal selection as pin 1. Can be configured for 0...20 mA or 4...20 mA.
Scaling can be:

0...20 / 4...20 mA	=	-100...400°C
or		
0...20 / 4...20 mA	=	0...100°C
or		
0...20 / 4...20 mA	=	a temperature range selectable within the working temperature range (e.g. 50...80°C)

maximum burden 330 Ohm

Connect only either pin 2 or pin 5!

Pin 6: setpoint current input; configuration and scaling as pin 5.

Burden 320 Ohm approx. Maximum voltage 15 V!

Connector plug, 6-pin Cat. No. EQS 057

Use shielded connecting cables. Connect the shielding to the plug case. The mass for all signals (pin 3) must not be connected with ground! If a connection to the ground cannot be avoided use a potential-free signal bridge in between.

Cover the unused connectors with protective caps!

8.10 Analogue inputs

A setpoint in the form of an analogue current or voltage signal can be provided by connection to the socket "Temp.-Signal" 52 S (see Item 8.9).

By pressing the key [ANALOG I / O 1] in the SHIFT mode the display shows

L1 ANALOGUE INP/OUTP

L2 INP = 0 OFF = 1_

Pressing 0 [LOCAL ENTER] selects the configuration and scaling of a setpoint input.

The display shows

L1 ANALOG INP. OFF = 0

L2 ON = 1 CONF = 2_.

Input 1 [LOCAL ENTER] switches in a previously configured input as setpoint, and L2 shows an "A" on the right, indicating that the setpoint is determined by the analogue input. This condition remains stored in case of a fault or after the power is switched off.

Input 0 [LOCAL ENTER] switches the setpoint back to the setpoint source I internal, i.e. key input.

Scaling takes place interactively by applying the voltage and current values corresponding to the appropriate temperature range limits to the corresponding input. For pin connections for voltage or current input on socket 52 S see Item 8.9. This method compensates various scaling errors, e.g. also those of the sources connected.

Pressing 2 [LOCAL ENTER] configures and scales the setpoint input. The display shows

L1 ANALOG INPUT

L2 U = 0 I = 1

Select a voltage range with 0 [LOCAL ENTER]. Voltages in the range 0...10.5 V can be handled. A current range is selected with 1 [LOCAL ENTER]. Currents in the range 0...22 mA can be handled.

The display shows

L1 ANALOG INPUT

L2 T_{min} = _ . °C

Input the lowest temperature of the range which corresponds to the lowest voltage or current value of the range to be scaled.

Example: range 0...120°C should correspond to 0...10 V approx.

Input 0, 0, 0, 0, 0 LOCAL ENTER.

The display shows

L1 ANALOG INPUT

L2 T_{max} = _ . °C

Input the upper limit of the temperature range 1, 2, 0, 0, 0 LOCAL ENTER

If the current input is selected, the programme asks whether 0...20 mA or 4...20 mA is required.

The display shows

L1 CURRENT INPUT

L2 0-20 = 0 4-20 = 1

Select 0 LOCAL ENTER or 1 LOCAL ENTER. This menu Item is omitted when the voltage input has been selected.

The display shows

L1 INPUT CAL.?

L2 YES = 1 NO = 0

Here the decision is made whether an automatic calibration procedure is started or whether the voltage or current values from the last calibration procedure are retained with input 0 LOCAL ENTER.

The display returns to the standard display.

With a new calibration the voltage or current source (e.g. setpoint unit, programmer) has to be connected up. The range limits have to be adjustable. The unit may switch to fault if the input signal is not connected. If this is the case it is necessary to connect the input signal first. Then press the reset key 0 and calibrate in the same way as described above.

Select the recalibration with 1 LOCAL ENTER. The display shows

L1 SET Umin

L2 YES = 1

When the voltage or current corresponding to the lower range limit is applied to the input, confirm this by the input of 1 LOCAL ENTER.

The display shows

L1 ----------wait----------

L2 XXXXXXXXXXXXXX

The calibration takes approx. 20 sec. The display then shows

L1 SET Umax

L2 YES = 1

When the voltage or current corresponding to the upper range limit is applied to the input, confirm this by the input of 1 LOCAL ENTER.

The display shows

L1 ----------wait----------

L2 XXXXXXXXXXXXXX

The calibration takes approx. 60 sec. The display then returns to the standard display. The calibration is finished.

Switch on the external setpoint from an analogue input as described in Item 8.10.2.

8.11 Analogue outputs

Two analogue output channels are available at the socket "Temp.-Signal" 52 S (see Item 8.9). They can be set to carry the temperature values

T_i = bath temperature

T_1 = temperature at ext. Pt 100 T_1

T_2 = temperature at ext. Pt 100 T_2

T_S = setpoint.

8.11.1 Temperature signal channel 1

Channel 1 can be configured at the socket 52 S on pin 2 as a voltage output or on pin 5 as a current output. Press the key ANALOG I/O 1 in SHIFT mode.

The display shows

L1 ANALOG INP/OUTP

L2 INP = 0 OUTP = 1

Select the processing of the outputs by pressing 1 LOCAL ENTER. The display shows

L1 Analog output

L2 Chan 1=1 Chan 2=2

Select channel 1 by pressing 1 LOCAL ENTER. The display shows

L1 Analog output

L2 U = 0 I = 1_

Select the current output with 1 LOCAL ENTER. The display shows

L1 CURRENT OUTPUT

L2 0-20=0 4-20=1

Select the required current range 0...20 mA or 4...20 mA by pressing 0 or 1 LOCAL ENTER.

The current range selection is omitted if the voltage range 0...10 V has been selected in the previous menu.

The display shows the scalings available for selection

L1 CONFIGURABLE=1

L2 analog output_

By pressing the key ↓ — (SHIFT ON) the pre-set scalings are displayed consecutively.

The selection is made by the input of the appropriate code (SHIFT OFF).

Configurable means that the temperature range required to correspond to the voltage range 0...10 V, current range 0...20 mA or 4...20 mA can be determined by setting the range start (T_{min}) and the range end (T_{max}).

The display shows

L1 CONFIGURABLE=1

L2 T_{min} =_ . °C

Example: range 20...220°C

Input 0, 2, 0, 0, 0 LOCAL ENTER. The display shows

L2 T_{max} =_ . °C

Input 2, 2, 0, 0, 0 LOCAL ENTER.

The following fixed scalings are available:

-200...400°C = 0...6 V = 10 mV/K
0°C = 2 V Code 2

-100...400°C = 0...10 V or 0...20 mA or 4...20 mA Code 3

0...100°C = 0...10 V or 0...20 mA or 4...20 mA Code 4

Then the display shows

L2 T_i T_1 T_2 T_S 0-3_

E.g. to set the bath temperature on channel 1 input 0 LOCAL ENTER. Similarly for the temperature signal of the external Pt 100 T_1 input 1 LOCAL ENTER etc.

The display then returns to the standard display.

8.11.2 Temperature signal channel 2

Channel 2 is purely a voltage output at socket 52 S on pin 1. The selection is made as described for channel 1 in Item 8.11.1 except that current ranges can not be selected.

8.12 Safety function

The operation of the safety devices of the units has already been described in Item 4.1. After starting up the user should confirm the correct operation of the safety devices. If the unit operates without supervision we recommend this check to be carried out daily.

8.12.1 Low-level cut-out

For the correct operation of the low-level cut-out it is essential that the float switch operates correctly. To check this, lower the level in the bath by draining away some of the liquid. When the bath level falls below the minimum level (approx. 20 mm above the upper heater winding) the pump, the heating and the refrigeration unit switch off on all poles.

The display shows the message

L1 LEVEL

L2 TOO LOW

and there is a warning beep.

To restart fill up the bath and press the reset key  twice (with approx. 1 sec interval).

8.12.2 Adjustable overtemperature limiter

To check it the switch-off point TO has to be set below the current bath temperature.

Note that an input of TO below the setpoint TS produces the message

L2 TS >> TO

and the previous value for TO is retained.

Therefore the setpoint TS usually has to be lowered by a few degrees first before this test can be carried out.

Then the overtemperature switch-off point can be set e.g. 1°C below the current bath temperature.

Example: Ti = 60°C

TS = 60°C

TO = 65°C

To check the operation of the overtemperature limiter, press 

(SHIFT OFF).

Input TS = 20°C, press 

. The display shows

L1 Ti = 60.00°C C

L2 TO : 65.00°C Ti I

If TU is shown in L2, press 

again!

Now input 0, 5, 8, 0, 0 

.

The switch-off point of the overtemperature limiter is now 2 K below the bath temperature Ti.

The display shows the message

L1 TEMPERATURE

L2 TOO HIGH !

with a beep. Heating, pump and refrigeration unit are switched off on all poles.

To restart the unit press the reset key 

.

The display shows the standard display.

Now press 

and set TO to a value above the bath temperature, e.g. 70°C:

Input 0, 7, 0, 0, 0 

. Then press the key 

once more.

The unit returns to normal operation.

In order to reduce the switching frequency of the refrigeration compressor a number of time delays have been incorporated. Therefore the refrigeration unit restarts with a considerable delay!

Note: The overtemperature switch-off point has to be set at least 25K below the fire point of the bath liquid used according to EN 61010.

Caution:In case of any malfunction in Items 8.12.1 and 8.12.2 the unit has to be taken out of use immediately and checked by an engineer, otherwise its safety is no longer ensured.

8.12.3 Connection potential-free contact "Combined fault" 12 N (Alarm out)

3-pin flange connector conforms to NAMUR recommendation NE 28

1 = n.o. (make)
2 = common
3 = n.c. (break)
1, 2 are linked when unit operation is OK

Use shielded connecting cables. Connect the shielding to the plug case. Cover the unused connectors with protective caps!

Coupling socket 3-pin Cat.No. EQD 047

8.13 Serial interface RS 232 C

9-pin sub-D socket 53 S

8.13.1 Data of the RS 232 C interface

Cables used (computer end)

Computer			Thermostat	
25-pin		9-pin	9-pin	
3	R x D	2	2	T x D (transmitted data)
2	T x D	3	3	R x D (received data)
7	SG	5	5	signal ground
6	DSR	6	6	DTR (data terminal ready)
4	RTS	7	7	CTS (clear to send)
5	CTS	8	8	RTS (request to send)

Use shielded connecting cables. Connect the shielding to the plug case. Cover the unused connectors with protective caps!

Using this interface it is possible to transfer the following data from or to a computer with a suitable interface:

1. Transfer of the setpoint from the computer to the thermostat
2. Read-out of the bath temperature T_i, the external temperature T_1, the external temperature T_2 and the setpoint on the unit
3. Transfer of the low temperature and overtemperature switch-off point
4. Read-out of the set overtemperature and low temperature switch-off point
5. Read-out of the fault signal
6. Transfer of ramp segments and their processing
7. Status signal
8. Read-out of the control parameter and transfer
9. External controller status and start

8.13.2 General principles

The interface operates with two stop bits, no parity bit and with 8 data bits. The transfer rate can be set to 4800 baud or 9600 baud (see Item 8.4.5).

Values from the computer can be transferred directly to the thermostat, i.e. transmitted, e.g. OUT, SEG and START commands, or data can be transmitted from the thermostat to the computer on request with an IN command. An OUT, SEG or START command, if transmitted correctly, is always acknowledged by the thermostat with the message "OK" followed by LF and CR.
This message, like any other response, has to be requested by the computer!

Any output command (OUT, SEG, START, STOP) switches the thermostat to remote operation. This can be recognized by an R (setpoint source RS 232) on the right in L2.

Then all the keys are locked except for the functions SHIFT 

and SHIFT 

.

If no output command follows from the connected computer the keyboard can be activated until the next output command by pressing the keys 

.

The data requests by the thermostat (IN-commands) only lock the programme keys SHIFT 

and SHIFT 

. All the other key functions are in operation.

In the following text the symbol "_" will be taken to mean blank (no character).

RS 232 interface and controller are operated by a single processor; for optimum control it is therefore advisable to have pauses of at least 100 msec between the interface commands.

8.13.3 Output commands

OUT_XXX.XX	Setpoint transfer with up to 3 places before the decimal point and up to 3 places behind. This includes the negative sign. Transfer can take various forms, e.g. for 5.00°C: 005.00, 05, 05.0, 005, 5.00.

A BASIC programme for the IBM PC which can be used to transfer any values between the set upper and lower limits (see Items 8.3.4 and 8.3.5) and which displays the response "O.K." or a possible error message may be as follows:

Note: set baud rate to 4800 (see Item 8.4.5)!

```
10    OPEN  "COM1:4800,N,8,2"  AS #1
20    CLS
30    LOCATE 8,5:PRINT SPC(70)
40    LOCATE 8,5
50    INPUT "Enter your command (without OUT_)";VALUE$
60    PRINT #1;"OUT_"+VALUE$
70    INPUT #1;A$
80    LOCATE 12,5:PRINT SPC(50)
90    LOCATE 12,5:PRINT "Response of the thermostat";A$
100   TI = TIMER+1
110   IF TI > TIMER THEN 110
120   GOTO 30
130   END
```

The following values can be transmitted similarly to the thermostat:

OUT_LXXX.XX	switching point for low temperature (usually set to the lower range limit of the thermostat)
OUT_HXXX.XX	overtemperature switch-off point. For safety reasons it is essential that, after the transfer, this value is read back with the command IN_9 and checked!
OUT_XPXXX.XX	setting of the control parameter X_p for the controller
OUT_TNXXX.XX	setting of the control parameter T_n
OUT_TVXXX.XX	setting of the control parameter T_v
OUT_RT1	switches the control variable to the source external Pt 100 T_1 (external control)
OUT_RT2	switches the control variable to the source external Pt 100 T_2 (external control)
OUT_RTi	switches the control variable to the source T_i (probe in the bath); control according to the bath temperature
SEG_XXX.XX_XX:XX	using this programme segment command a segment can be written into the programmer buffer. It indicates the target temperature and the segment time hours (2 digits max.) and minutes (59 max.). The segment start is formed by the current setpoint, i.e. before the transfer of a programme segment it is useful to transfer a setpoint as a segment start suitable for the subsequent segment, using OUT_XXX.XX.
SEG_(XX)_XXX_XX:XX	single segment with segment number, used when whole temperature programmes are to be loaded from the computer to the thermostat. Thus, in contrast to the command SEG_, several segments may be transmitted.

	The programme starts with the latest setpoint; therefore please check before START whether the setpoint suitable for the first segment is available in the unit.
OUT_TBX.X	the tolerance range value is ½ of the value of the total range; i.e. is 0.5 is 0.5 K; range 0.1...9.9 K. 0.0 switches off the tolerance range function.
OUT_CYXX	number of the programme cycles, range 1...99. 0 switches off the function, i. e. the programme is repeated until it is stopped manually.
START	starts the segment contained in the programme buffer
STOP	stops the programme segment run. With START the programme segment starts again from the beginning.

8.13.4 Requesting data from the thermostat

IN_1 indication of the bath temperature (T_i), i.e. the request of the thermostat to transmit the bath temperature

IN_2 indication of the temperature value at the external probe T_1

IN_3 indication of the current setpoint (T_S)

IN_4 status signal, 7 characters

char 1 from the left:	overtemperature fault = 1, no fault = 0
char 2:	low level fault = 1, level OK = 0
char 3:	programmer segment running = 1, programmer segment off = 0
char 4:	control according to the bath temperature (T_i) = 0 T_1 = 1, T_2 = 2
char 5:	setpoint set by analogue inputs = 1, analogue inputs off = 0
char 6:	indicates whether external Pt 100 T_1 is connected = 1, or not connected = 0
char 7:	indicates whether external Pt 100 T_2 is connected = 1, or not connected = 0

IN_5 invalid

IN_6 invalid

IN_7 indication of the temperature of the external probe T_2

IN_8 indication of the current low temperature switch-off point T_U

IN_9 indication of the current overtemperature switch-off point T_O

IN_A indication of the current value of X_p

IN_B indication of the current value of T_n

IN_C indication of the current value of T_v

Examples:

A BASIC programme used to transfer values from the thermostat to the computer and to display them specifying the channel number (e.g. 1 for IN_1, i.e. the bath temperature), is as follows:

Note: set baud rate to 4800 (see Item 8.4.5)!

```
10    OPEN "COM1:4800,N,8,2" AS #1
20    CLS
30    LOCATE 8,5:PRINT SPC(20)
40    LOCATE 8,5
50    INPUT "Channel No.";NR$
60    PRINT #1;"IN_"+NR$
70    INPUT #1;A$
80    LOCATE 12,5:PRINT SPC(50)
90    LOCATE 12,5:PRINT "Response of the thermostat";A$
100   TI = TIMER+1
110   IF TI > TIMER THEN 110
120   GOTO 30
130   END
```

The isolation of the status data may be as follows:

LEFT $ (A$,1)	=	overtemperature fault
MID $ (A$,2,1)	=	low-level fault
MID $ (A$,3,1)	=	programme segment running
MID $ (A$,4,1)	=	control by T_i, T_1 or T_2
MID $ (A$,5,1)	=	analogue input on/off
MID $ (A$,6,1)	=	external Pt 100 T_1 connected
RIGHT $ (A$,1)	=	external Pt 100 T_2 connected

8.13.5 Error messages on the computer

The following error messages can be reported from the thermostat to the computer during operation:

ERR-2:	invalid inputs (e.g.: overflow of the input buffer)
ERR-3:	invalid command
ERR-5:	invalid command when switching the control variable for the controller, e.g. external controller OUT_RT2. Other command than OUT_RTI, OUT_RT1, OUT_RT2.
ERR-6:	temperature value cannot be set
ERR-7:	syntax error in channel number
ERR-8:	channel does not exist

8.14 Timing clock function

The unit is equipped with a clock indicating day, month, year, weekday, hours and minutes and provides these for the timing function.

The clock is backed for approx. 10 years by a built-in battery so that the clock continues to operate even when the unit is not connected to the electrical supply.

8.14.1 Setting and indication of date and time

This function is only required when changing from summer to winter time and vice versa, or when the unit is being operated in other time zones. Date and time are set at the factory when the unit is started up for the first time.

By pressing the key 

in the SHIFT mode the display shows

L1 Clock = 0 Activ = 1

L2 SET = 2 FUNCT = 3

By the input of 0 

date and time are indicated. 

returns to the standard display.

The input of 2 

(SET) allows date and time to be altered. The display shows:

L1 DA MO YE H MI

L2 _ . . :

Day, month, year, weekday, hours and minutes are now input in sequence.

Weekday code:

1	Monday
2	Tuesday
3	Wednesday
4	Thursday
5	Friday
6	Saturday
7	Sunday

The hours are input from 0 to 24 (factory-set to Central European Time).

Example:

L2 19.01.98 3 16:05

Terminate the input with 

.

8.14.2 Timing clock function

By pressing the key 2 in the SHIFT mode the display shows the menu as described in Item 8.14.1. Select the timing function FUNCT = 3 with 3 LOCAL ENTER.

The display shows

L1 Thermostat ON = 1

L2 OR OFF = 0

Here it can be selected whether the thermostat should automatically switch on or off at the time to be selected subsequently in Item 8.14.3. Input either 1 or 0 as appropriate. A display to input date and time appears.

Input here the switching point for the timing function as described in Item 8.14.1 and enter it with LOCAL ENTER. The display returns to the standard display.

8.14.3 Activating the timing function

By pressing the key 2 in the SHIFT mode the display shows the selection menu as described in Item 8.14.1. Activate the timing function with ACTIV = 1 by the input of 1 LOCAL ENTER. Again the display shows

L1 Clock

L2 ON = 1 OFF = 0

Normally 1 LOCAL ENTER is input here to activate the timing function.

The timing clock symbol now appears in line L1 before the last position. If the previous selection was that the thermostat should switch on automatically, the thermostat now switches off and starts up at the selected time.

When the unit has been switched off by the timing function, the display shows

L2 CLOCK STOP!

The activated timing function can always be switched off with off = 0, i.e. with 0 LOCAL ENTER.

In addition the timing function can be cancelled at any time with ESC.

9 Maintenance

9.1 Safety notes in case of repairs

Always pull out the mains plug or switch off the main switch for all repair and cleaning operations! Repairs on the control unit with cover removed must be carried out by a qualified electrician only.

9.2 Repair and re-initilisation

LAUDA thermostats are largely free from maintenance. Dirty thermostatic liquid should be removed through the drain cock and replaced. If the unit should become faulty it may be advisable to return only the faulty module where appropriate.

When replacing the control unit, check whether the new control unit has been programmed for the correct basic unit type. If the correct type does not appear after having switched on the mains switch, proceed as follows:

Mains switch off, press the keys SHIFT and PAR 6 simultaneously, and at the same time switch on the supply. Wait until the following display appears:

L1 RK 20 K = 0 K 12 K = 1

L2 Type

Release the keys SHIFT and PAR 6, and go through the menu with the key ↓ — until the required type appears. Input the code number and enter with LOCAL ENTER.

Example:

L1 RUK 40 = 20 RUK 50 = 21

L2 Type

The type designations are shown abbreviated, e.g. RUK 40 instead of RUK 40 S.

The units are protected by fuse cut-outs (except RUL 80, RUL 90). These are accessible after removing the back of the control unit. The control circuit of the unit has a separate fuse; a fuse 5 x 20 F4A is located in the control unit. This is accessible after removing the cover. When the fuse has blown the green lamp in the mains switch does not light up.

9.3 Maintenance of the refrigeration system

The refrigeration system operates largely without maintenance. If an air-cooled unit is being operated in a dusty atmosphere we recommend to clean the condenser of the refrigeration system at intervals of 4 to 6 months. This is best done by blowing compressed air or nitrogen into the ventilation openings for a few minutes. Unscrew the front grille if necessary.

Repair and disposal note:

The cooling circuit is charged with HFHC refrigerant. See the label inside the unit. The repair and disposal must be carried out by a qualified refrigeration engineer only!

9.4 Cleaning

The unit can be cleaned using a cloth moistened with water with the addition of a few drops of (domestic) detergent. No water must find its way into the control unit.

The user is responsible for any necessary decontamination if dangerous materials have been spilled on or inside the unit. This applies in particular if the unit is removed for a different use, for repair, storage etc.

The method of cleaning or decontamination is determined by the expertise of the user. If the user has any doubts on whether this may damage the unit he is to contact the manufacturer.

9.5 Transport and storage

Warning: in case of danger of frost (e.g. transport in winter) the condenser of water-cooled units has to be emptied! For this operation warm up the bath to approx. 20°C, disconnect the water hose from the water tap. Set the setpoint to e.g. -20°C and, immediately on start-up of the first-stage compressor, blow compressed air into the water supply hose (seen from the back: on the left side).

Set the drain hose as low as possible so that the unit is emptied completely. Switch off the unit immediately.

9.6 Spares ordering

When ordering spares please specify the equipment type and number on the label. This avoids queries and prevents the supply of wrong goods!

We shall always be happy to deal with queries, suggestions and complaints.

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Fax: (+49) (0) 9343/ 503-222
E-mail info @ lauda.de
Internet http://www.lauda.de

10 Accessories for LAUDA Ultra-Kryomats®

Racks in stainless steel
for test tubes, centrifuge tubes etc.

All RUK units up to 3 racks

RE 13	for 56 tubes 10 - 13 dia., 80 mm immersion	UG 070
RE 18/1	for 33 tubes 14 - 18 dia., 80 mm immersion	UG 071
RE 18/2	for 33 tubes 14 - 18 dia.,110 mm immersion	UG 072
RE 30	for 14 tubes 24 - 30 dia.,110 mm immersion	UG 073

RUL 80(-D), RUL 90(-D) 1 rack

RF 18/1	for 20 tubes 14 - 18 dia., 80 mm immersion	UG 074
RF 18/2	for 20 tubes 14 - 18 dia.,110 mm immersion	UG 075

Non-return fitting (RUL/RUK without P and S) UD 125
for automatic venting of the connecting hoses when thermostating an open external bath

Remote operation FBK LUZ 906
without cable set
The electronic control unit is placed separately from the unit and linked to it by cable.

Cable set for FBC length 5 m UK 235

Cable set for FBC length as specified UK 238

LAUDA Pt 100 platinum resistance thermometers
to DIN IEC 751 Class A for external control and other temperature measurement

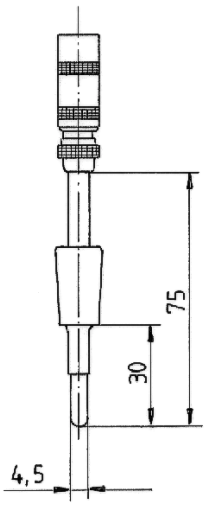
Pt 100-42
all-glass version with NS 14/23 ground taper DIN 12242
Temp. range -100...300°C
50% response time 0.8 sec
Overall length approx. 115 mm
4-wire circuit ETP 049
Fig. 1

Pt 100-44
all-glass version with NS 14/23 ground taper DIN 12242
Temp. range -100...300°C
50% response time 0.8 sec
Overall length approx. 320 mm ETP 007
Fig. 2

Pt 100-66
as Pt 100-44
Overall length approx. 430 mm ETP 008
Fig. 2

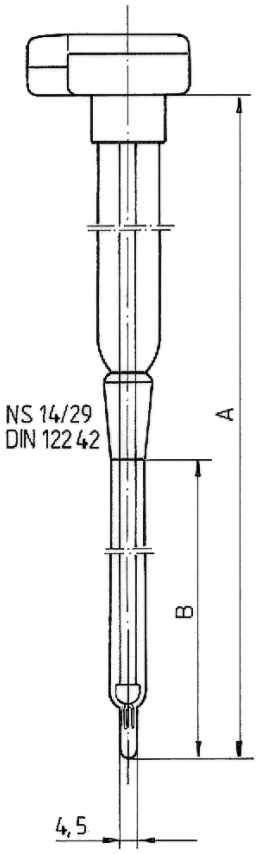
Pt 100-90 stainless steel protection tube 4 mm dia. Temp. range -100...300°C 50% response time 1.5 sec Overall length approx. 120 mm 4-wire circuit Fig. 3	ETP 050
Pt 100-70 stainless steel protection tube 4 mm dia. Temp. range -200...300°C 50% response time 1.5 sec Overall length approx. 290 mm 4-wire circuit Fig. 3	ETP 009
Pt 100-92 stainless steel protection tube 4 mm dia. with attached Silicone cable 2 m long and plug Temp. range -100...200°C 50% response time 3 sec Overall length approx. 250 mm 4-wire circuit Fig. 4	ETP 051
Connecting cable Lemo/Lemo for external control on all units with Lemo connector using Pt 100 (stainless steel), except Pt 100-94, length 2.5 m	UK 246
Connection cable as above length as specified	UK 247
Screw clamp fitting stainless steel, with Teflon pressure ring for Pt 100 resistance thermometer 4 mm dia. Fig 5	HX 078

Fig. 1



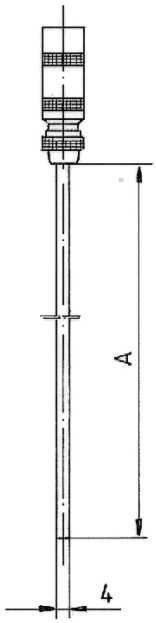
Pt 100-42

Fig. 2



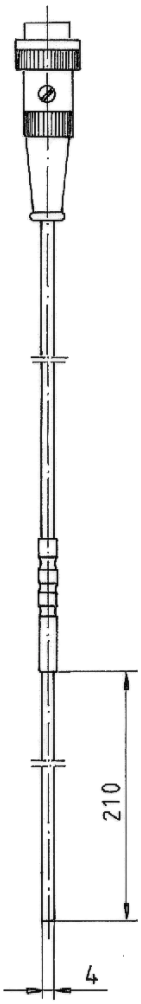
	A	B
Pt 100-44	300	135
Pt 100-66	410	245

Fig. 3



	A
Pt 100-90	80
Pt 100-70	250

Fig. 4



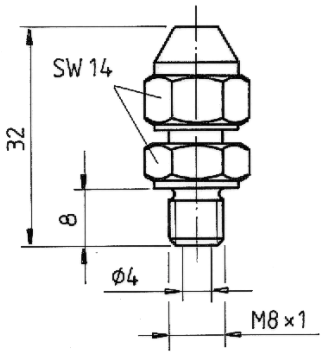


Fig. 5

Notes for trouble-shooting for LAUDA Thermostats with P - electronics

Each repair requiring the opening of the control part by means of tools and each work at the electronic part may only be done by a trained technician !

Malfunction	Fault	Reason	Remedy
Green signal lamp of mains switch not alight	Control fuse has actuated		Replace fuse on PCB ”MP Mains” 5 x 20; F4A
		Overload on PCB	Replace PCB ” MP Mains ”
Display: ”Level too low ”	Bath level too low	Evaporation; external consuming device not refilled	Fill in bath liquid; press reset button twice
		Leakage in hose connections	Check hoses and their connection; if necessary replace them; fill in bath liquid; press reset button twice
	Level detector		Check level detector, plugs and hall sensors; if necessary replace them; check their function carefully For USH 400(/6) fill in bath liquid up to the level mark
Display: ” Temperature too high ”	Temperature probe	Temperature difference between two probes > 15°C	Replace bath temperature probe (double Pt 100). For USH 400(/6) please check both single Pt 100.
	Temperature of bath liquid above over-temperature switch-off point (To)	Overtemperature switch-off point (To) set too low	Press reset button; adjust overtemp. switch-off point (To) at an higher value; press reset button
		Triac or triggering	Replace triac or PCB "MP Mains"
Display: ” External fault "	Contact input 14 N ”Fault ” is used	Pins ½ not connected	Reason for malfunction caused by external system
		No signal transmitter connected to socket 14 N, though selection at PAR level is activated	Switch off function ” Contact input Fault ” at PAR level; see operating instructions
Display: ” Ts > To	Wrong inputs	Setpoint adjusted above overtemperature switch-off point (To)	Adjust overtemperature switch-off point (To) at an higher temperature; pay attention to bath liquid, flash point etc. !!
		Overtemperature switch-off point adjusted below setpoint (Ts)	First adjust setpoint (Ts) at a lower value then set requested overtemperature switch-off point
Display: “Ts < Tu”	Wrong input	Setpoint adjusted below low-temperature switch-off point (Tu)	Adjust low-temperature switch-off point (Tu) at a lower value
		Low-temperature switch-off point adjusted above setpoint (Ts)	First adjust setpoint at an higher temperature then set requested low-temperature switch-off point (Tu)

Notes for trouble-shooting for LAUDA Thermostats with P - electronics

Malfunction	Fault	Reason	Remedy
Setpoint Ts is not adjustable but will disappear	Operating error	Setpoint is determined by the analogue input; see right side of display L2: A	Switch off analogue input
Sound signal appears when a button is pressed		Another function blocks the keybord e.g.: programme runs; RS 232 active; Parameter etc.	Leave the function or press ESC (RS 232) (R appears on the right side of display L2); Stop access and press the button “Local”
Display: ”Tu – Cursor flashes” acoustic signal switches compressor off after 1 min.	Wrong input	Actual value is ≤ = Tu, resp. setpoint adjusted too close to low-temperature switch-off point Tu; bath temperature (Ti) falls below Tu	Set low-temperature switch-off point (Tu) at a lower value
Display ”Out of range”	Wrong input	Tried to enter values being out of admissible ranges; Ts,To,Tu being out of operating temp.	Choose the right values taking into consideration their limitations; check bath liquid or configuration after having switched on the unit
		Programme input out of operating temperature range of the unit	Enter admissible values
		Value for Xp, Tn, Tv above 199,9	Enter admissible values
Tu or To is not adjustable; “Out of range ”		Input values are outside of temperature limits of the type of unit or initialization does not fit to the type of unit	Reinitialize type of unit: (see operating instructions “Maintenance”); may also return ***Default-values***
Display: “TA” (only for USH 400(/6)		Motor chamber temperature > 55 °C	Surrounding temperature of the part of the thermostat may be too high (see operating instructions 5.2.8)
Display: ↓ (only for USH 400(/6) RUL and RUK)		Level too low	Fill in bath liquid ; (see operating instructions 5.2.3)
Display: ↑ (only for USH 400(/6) RUL and RUK)		Level in the vessel is close to overflow; heater switches off	Either reduce the amount of thermal liquid or install an other vessel Attention: HOT !!!
Display: “Upper limitation of oil > limitation of unit” (cancelled beginning with software version 1.06)		Admissible working temperature range of bath liquid exceeds operating temperature range of the unit	Bath liquid is accepted, no other steps necessary; unit limitations valid
Setpoint cannot be selected by means of keyboard		Check setpoint selection; see right side of display L2; P=Programme; A=Analogue; R=RS 232	Switch setpoint selection to I=Internal
Display: “External fault – clock stop!”	Clock does not run	RAM defective	Unit has to be switched on once again; set date and time once again; see operating instructions if necessary replace RAM

Notes for trouble-shooting for LAUDA Thermostats with P - electronics

Malfunction	Fault	Reason	Remedy
Display: "Internal Pt 100 defective"	Double Pt 100 for bath temperature or safety temperature	Interruption, short circuit or temperature deviation of bath temperature probes too important	Replace double Pt 100 for bath temperature For USH 400(/6) please check both single Pt 100
Display: "Ext. Pt 100 not connected"		Tried to switch over to external control without connecting an external Pt 100	Continue to work with internal control or connect external Pt 100 for T1 or T2; look at display for control variables I, 1 or 2; check display for T1 or T2
		Tried to calibrate Pt 100 being not connected	
Display: "Correcting value too high"	Important deviation of Pt 100 from standard values	Value input differing from the basic value that is indicated by more than 5 K	Check temperature reference thermometer, check Pt 100; replace PCB "CPU"
Scale of analogue outputs shows discrepancies		Outputs not correctly calibrated	Calibrate the analogue output channels (see operating instructions)
Unit does not heat though heating is indicated	Triac		Replace triac
	Heater	Defective	Replace heater
		Interruption	Eliminate
		Electronics	Replace PCB "MP Mains"
		Controller output limitation at PAR level too small	Enter higher values at PAR level (e.g. 100 %)
Pump does not run	Temperature safety cut-out in pump has actuated Pump stops	Motor blocked	Turn propeller of motor; if necessary replace it; clean pump
		Viscosity of bath liquid too high	Use other bath liquid; wait until motor has cooled down
Bath temperature rises clearly above adjusted setpoint (Ts) Heating indication ON		Controller	Replace PCB "MP Mains" or PCB " CPU "
Heating indication OFF		Triac	Replace triac
Temperature rises slowly above adjusted setpoint Heating indication OFF	Cooling not sufficient	Heat emission of pump	Connect cooling water supply or other kind of cooling
Display shows wrong temperature (Ti, T1, T2)		Temperature probe	Replace double Pt 100 or external Pt 100 T1, T2
Display is dark	Temperature cut-out in transformer has actuated	Overload caused by short – circuit	Replace PCBs or control unit

Notes for trouble-shooting for LAUDA Thermostats with P - electronics

Malfunction	Fault	Reason	Remedy
Unit does not work at adjusted setpoint		Wrong control parameters adjusted	Enter new values or start autoadaption
Temperature control by means of external controller not stable		Thermal contact of bath liquid and external measuring point not sufficient	Improve circulation through external consuming device or thermal contact to ext. Pt 100
Unit does not cool down		Controller output limitation at PAR level too small	Adjust higher value at PAR level (e.g. -100 %)
	Compressor defective		Replace refrigeration unit – by refrigeration engineer !!
	Leakage in refrigeration system		Clear leakage, fill in refrigerant – by refrigeration engineer !!
	Compressor does not run	Compressor without tension	Eliminate line interruption
		Triggering defective	Replace PCB ”MP Mains ”
Unit does not cool down	Compressor does not run	Pressure switch has actuated	Unscrew grid, clean condenser, blow through compressed air, improve ventilation
	Solenoid valves do not work correctly	Triggering defective	Replace PCB ” MP Mains ”
Compressor switches ON and OFF in regular periods; temperature constancy very bad	Condensation pressure too high	Fan defective	Replace fan motor
		Fan speed (only RK)	Check speed or speed controller
	Condenser dirty	Dust	Unscrew grid, from the back side blow compressed air or nitrogen through condenser
		Ventilation disturbed	Enlarge distance to nearby units or walls
		Ambient temperature too high	Air the room
Insufficient cooling in the lower temperature range		Bath liquid contaminated by condensate	Replace bath liquid to suit bath temperature
	Cools down to approx. 0°C only	Bath liquid not suitable (water)	Use water/ glycol mixture

BESTÄTIGUNG / CONFIRMATION / CONFIRMATION

An / To / A:
LAUDA Dr. R. Wobser • LAUDA Service Center • Fax: +49 (0) 9343 - 503-222

Von / From / De :

Firma / Company / Entreprise: _____

Straße / Street / Rue: _____

Ort / City / Ville: _____

Tel.: _____

Fax: _____

Betreiber / Responsible person / Personne responsable: _____

Hiermit bestätigen wir, daß nachfolgend aufgeführtes LAUDA-Gerät (Daten vom Typenschild):
We herewith confirm that the following LAUDA-equipment (see label):
Par la présente nous confirmons que l'appareil LAUDA (voir plaque signalétique):

Typ / Type / Type :	**Serien-Nr. / Serial no. / No. de série:**

mit folgendem Medium betrieben wurde
was used with the below mentioned media
a été utilisé avec le liquide suivant

_____

_____

_____

_____

Darüber hinaus bestätigen wir, daß das oben aufgeführte Gerät sorgfältig gereinigt wurde, die Anschlüsse verschlossen sind, und sich weder giftige, aggressive, radioaktive noch andere gefährliche Medien in dem Gerät befinden.

Additionally we confirm that the above mentioned equipment has been cleaned, that all connectors are closed and that there are no poisonous, aggressive, radioactive or other dangerous media inside the equipment.

D'autre part, nous confirmons que l'appareil mentionné ci-dessus a été nettoyé correctement, que les tubulures sont fermées et qu'il n'y a aucun produit toxique, agressif, radioactif ou autre produit nocif ou dangeureux dans la cuve.

Stempel **Seal / Cachet.**	**Datum** **Date / Date**	**Betreiber** **Responsible person / Personne responsable**

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